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U.S. Department of the Interior
Bureau of Land Management

Draft Programmatic Environmental Impact Statement for Utility-Scale Solar Energy Development

Volume I: Executive Summary, Chapters 1–7

Mission statement

The Bureau of Land Management sustains the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations.

On the cover

Gemini Solar Project, Nevada (Credit: Bureau of Land Management)

DOI-BLM-HQ-3000-2023-0001-RMP-EIS

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DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT FOR UTILITY-SCALE SOLAR ENERGY DEVELOPMENT, DOI-BLM-HQ-3000-2023-0001-RMP-EIS

Responsible Agency: United States Department of the Interior, Bureau of Land Management (BLM)

Document Status: Draft (X) Final ()

Abstract:

The BLM is undertaking a programmatic analysis to evaluate potential amendments to BLM resource management plans in Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming to facilitate solar energy development on public lands while avoiding resource conflicts. The potential amendments would help guide applications for solar development rights-of-way away from public lands with a known high potential for resource conflict while maintaining sufficient flexibility to adjust development siting configurations for site-specific resource concerns identified through project-specific analyses. The potential modifications would support national climate priorities and renewable energy deployment goals for public lands and would provide management direction to respond to estimated renewable energy development demand over the next 20 or more years.

The BLM is evaluating a number of alternatives as part of this Draft Programmatic Environmental Impact Statement (EIS). The No Action Alternative would continue the BLM's existing management of utility-scale solar energy development under current land use plans. The five Action Alternatives would amend resource management plans to identify public lands available for and public lands excluded from applications for utility-scale PV solar energy development in the 11-state planning area, while eliminating the current variance process requirement that applies to some public lands under the existing plans. The Action Alternatives would also amend existing plans to update the programmatic design features required for utility-scale solar development on public land. Under the Preferred Alternative, Alternative 3, lands would be excluded from utility-scale solar energy application based on a number of resource-based exclusion criteria. Remaining public lands within 10 miles of existing and planned transmission lines with capacities of 100 kV or greater would be available for solar application, while other public land would be excluded. Alternative 3 would make approximately 22 million acres across the 11-state planning area available for utility-scale right-of-way application.

Review Period: The public comment period on the Draft Programmatic EIS will be closed after 90 calendar days following publication of the EPA's Notice of Availability in the Federal Register or 15 days after the BLM holds the last public meeting. Comments can be submitted through the ePlanning website, listed below.

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ePlanning website: https://eplanning.blm.gov/eplanning-ui/project/2022371/510

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Executive Summary

ES.1 Introduction

The U.S. Department of the Interior (DOI) Bureau of Land Management (BLM) is undertaking a macro-scale evaluation of the potential environmental, cultural, and economic impacts of several modifications to its current solar energy program. These modifications are being considered to improve and expand the BLM's utility-scale solar energy planning in response to national priorities and goals for renewable energy development and changes in solar technologies since 2012. The modifications would update the *Approved Resource Management Plan Amendments/Record of Decision (ROD) for Solar Energy Development in Six Southwestern States* (BLM 2012a) (the "Western Solar Plan"), which applied to Arizona, California, Colorado, Nevada, New Mexico, and Utah; and would expand the BLM's solar energy planning to include Idaho, Montana, Oregon, Washington, and Wyoming. These states are collectively referred to as the 11-state planning area. The BLM has initiated and is preparing this *Programmatic Environmental Impact Statement (Programmatic EIS) for Utility-Scale Solar Energy Development* to analyze various alternatives for changes to land use allocations, permitting processes, and programmatic design features, and evaluate the environmental, cultural, and economic impacts of those potential changes. The Notice of Intent (NOI) to prepare this Programmatic EIS and amend Resource Management Plans (RMPs) was published in the *Federal Register* on December 8, 2022 (87 FR 75284).

The 11-state planning area includes approximately 162 million acres of lands that are administered by the BLM under principles of multiple use and sustained yield, consistent with the Federal Land Policy and Management Act of 1976, as amended (FLPMA). Under FLPMA, the BLM strives to make land use decisions that meet the nation's many needs, are environmentally responsible, and take into account the use and enjoyment of the public lands by present and future generations. The BLM seeks to advance its solar energy program consistent with balanced management for important values (such as recreational use, agricultural use, and other energy development) and resources protection, including National Monuments and National Conservation Areas; wilderness areas and wilderness study areas; other specially designated areas; wildlife and big game; water resources; and cultural, historic, and paleontological resources; as well as the restoration of lands and resources where appropriate.

This Utility-Scale Solar Energy Programmatic EIS evaluates the environmental, social, and economic impacts of the agency's proposed action and alternatives in accordance with the National Environmental Policy Act (NEPA), the Council on Environmental Quality's regulations for implementing NEPA (Title 40, Parts 1500–1508 of the *Code of Federal Regulations* [40 CFR Parts 1500–1508]), and applicable BLM and DOI authorities.[1]

[1] For the BLM, these authorities include the BLM's NEPA Handbook (BLM 2008a); DOI's NEPA Implementing Procedures, 43 CFR Part 46; and Chapter 11 of the DOI's Departmental Manual (DOI 2020).

ES.2 Background and Purpose and Need

BLM-administered lands cover vast areas and have the potential to support substantial contributions to meeting the nation's energy needs. To promote the use of solar energy sources, the BLM considers and, where appropriate, approves applications for environmentally sound development of renewable energy on BLM-administered lands.

The efficient review of energy development proposals is an important component in achieving national energy goals. Power from solar, wind, and geothermal energy development on BLM-administered lands contributes to meeting the nation's energy needs. As of December 2022, the BLM had permitted over 9 GW of solar energy development (BLM 2023a), 3 GW of wind energy development, and 1.6 GW of geothermal energy development on BLM-administered lands. Additionally, as of May 2023 the BLM had also permitted 17 transmission connections (i.e., generation-ties or gen-ties) crossing BLM-administered lands to connect renewable energy projects on lands not administered by the BLM to existing electricity transmission (BLM 2023b). Department of Energy (DOE) forecasts indicate that solar energy development across the United States will continue to increase rapidly over the next several decades (DOE 2021).

ES.2.1 BLM's Purpose and Need

The purpose of the proposed action is to facilitate improved siting of utility-scale solar energy development by identifying areas of BLM-administered lands where solar energy development proposals may encounter fewer resource conflicts than in other areas as "solar application areas," and identifying areas of BLM-administered lands with known high potential for resource conflicts as "exclusion areas." There is a need to improve the solar development application process by providing development opportunities in specified solar application areas while maintaining sufficient flexibility to account for site-specific resource considerations on a case-by-case basis under subsequent project-specific NEPA analysis. Although additional site-specific environmental analysis will be needed to support future project-level decisions to authorize utility-scale solar energy development, this macro-scale programmatic land use planning effort will provide a framework for making those decisions in a systematic and consistent way. Applications processed under this framework are expected to have a higher likelihood of alignment with the BLM's multiple use and sustained yield mission than under the Western Solar Plan, leading to more expedient processing without jeopardizing critical resources or other uses of BLM-administered lands.

This programmatic planning effort also provides updates that respond to changes that have occurred over the 11 years since the BLM issued the Western Solar Plan. First, utility-scale solar energy development on and off BLM-administered lands has significantly increased and is expected to continue to increase in view of a growing public interest in carbon pollution-free energy generation. Second, due to technological advancements as well as economic forces affecting power markets, the composition of proposed solar energy generation projects is now different, with more focus by solar developers in the United States on using photovoltaic (PV) technology. Third, the BLM is receiving increasing interest (through applications for PV solar energy development on BLM-administered lands) in more northern latitudes beyond the six states subject to the Western Solar Plan.

In response to these changes, the BLM needs to update its administration of the public lands to facilitate responsible siting of solar energy development. The BLM seeks to accomplish this by amending its land use plans in the six states subject to the Western Solar Plan and those in the expanded area of the five additional states to exclude solar energy development applications from areas where protection is warranted based on critical need(s). The land use plan amendments would also involve updating design features and environmental evaluation processes and incorporating new information and additional environmental analysis.

This planning effort will serve the BLM's administration and management of public lands under the principles of multiple use and sustained yield and respond to direction in the Energy Act of 2020, which exhorts the Secretary of the Interior to support national renewable energy goals on public lands including the goal laid out in that Act to "seek to permit at least 25 GW of electricity from wind, solar and geothermal projects by 2025." It is also consistent with and responds to E.O. 14008, *Tackling the Climate Crisis at Home and Abroad* (86 FR 7619) issued in February 2021, which states that it is the policy of the United States

> *"to organize and deploy the full capacity of its agencies to combat the climate crisis to implement a Government-wide approach that reduces climate pollution in every sector of the economy; increases resilience to the impacts of climate change; protects public health; conserves our lands, waters, and biodiversity; delivers environmental justice; and spurs well-paying union jobs and economic growth, especially through innovation, commercialization, and deployment of clean energy technologies and infrastructure."*

In addition, this effort addresses E.O. 14057, *Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability* (86 FR 70935), issued in December 2021, which directs the federal government to lead by example to achieve a carbon pollution-free electricity sector by 2035 and net-zero emissions economy-wide no later than 2050.

ES.2.2 BLM's Decisions to be Made Under the Land Use Planning Process

FLPMA requires the BLM to develop land use plans, also called RMPs, to guide the management of the lands it administers. An RMP typically covers BLM-administered lands within a particular BLM field office. The BLM's *Land Use Planning Handbook* (BLM 2005a) provides specific guidance for preparing, amending, and revising land use plans.

The BLM periodically reviews and amends its land use plans to reflect changes in the scope and nature of the appropriate use of public lands. Through these amendments, the BLM may identify land use allocations or designations, including right-of-way (ROW) avoidance areas (which may be available for development) or exclusion areas (which are not available for development). The BLM may also identify areas open for application for renewable energy development (e.g., solar application areas). In addition, the BLM may identify terms and conditions that apply to solar application areas, including best management practices to minimize environmental impacts and limitations on other uses that would be necessary to maintain the ROW values (BLM 2005a). As part of the present effort, land use plans in the 11-state planning area would potentially be amended to address solar energy development (see Appendix A for a list of the proposed plan amendments associated with this Programmatic EIS). The amendments would identify for their respective land use plans the exclusion areas and solar application areas as well as incorporate programmatic design features. Land use plans that are undergoing amendment or revision separate from but concurrent with the development of this Programmatic EIS will be reviewed to identify and resolve inconsistencies between the Programmatic EIS and those separate planning efforts.

On the basis of the analyses presented in this Programmatic EIS and considering the elements described above, the BLM is considering making the following programmatic and land use planning decisions that will update the BLM's Western Solar Plan across an 11-state planning area (excluding the Desert Renewable Energy Conservation Plan [DRECP] area; see Section 1.1.6) to support national renewable energy goals as well as conservation and climate priorities:

1. Land use plan amendments that allocate BLM-administered lands to exclude them from utility-scale solar energy development;
2. Land use plan amendments that allocate BLM-administered lands to make them available for utility-scale solar energy development application;
3. Land use plan amendments to remove variance area land use allocations (see Section 2.4.3);
4. Land use plan amendment to de-allocate the Los Mogotes SEZ in Colorado as a solar energy development priority area (see Section 2.1 for further discussion);
5. Land use plan amendments to update Renewable Energy Development Areas (REDAs) in Arizona to align lands available for or excluded from solar applications with the selected alternative to maintain program consistency of land use allocations across western states; and
6. Land use plan amendments that establish required programmatic design features for utility-scale solar energy development on BLM-administered lands to ensure the most environmentally responsible development and delivery of solar energy.

ES.2.3 BLM's Scope of Analysis

Because of increased interest in solar energy development on BLM-administered lands outside of the six-state area addressed under the Western Solar Plan and to provide planning consistency across the 11 western states, the BLM has determined that the planning area, or geographic scope, of this Programmatic EIS will include an 11-state planning area (i.e., Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming; see Figure 1-1). The *decision area* (lands for which the BLM has authority to make land use and management decisions) includes all BLM-administered lands in these 11 states, except for lands covered by the decision area of the DRECP Amendment to the California Desert Conservation Area Plan, Bishop RMP, and Bakersfield RMP.

The scope of this impact analysis includes an assessment of the environmental, cultural, and economic impacts of PV utility-scale solar energy developments, as well as the impacts of supporting facilities and transmission connections from these facilities to the existing electricity transmission grid. Although the Solar Programmatic EIS considers the impacts of constructing, operating, maintaining, and decommissioning the supporting facilities and transmission connections such as roads, transmission lines, and natural gas or water pipelines, the land use plan decisions to be made (e.g., exclusions, solar application areas) will apply only to utility-scale solar energy developments (i.e., solar energy generation facilities). Management decisions for supporting infrastructure would continue to be made in accordance with existing land use plans and applicable policy. Solar energy developments would be further analyzed in project-specific environmental reviews in accordance with NEPA, including analysis of both the energy development and supporting infrastructure, as appropriate.

ES.2.4 BLM's Alternatives

This Programmatic EIS examines five Action Alternatives, each of which would involve the identification of BLM-administered lands available for or excluded from utility-scale solar applications in the 11-state planning area, as well as presenting updated programmatic design features for solar development. This Programmatic EIS also examines a No Action Alternative that would continue the BLM's existing management of utility-scale solar energy development under approved land use plans, including the 2012 Western Solar Plan, as further amended since 2012, and under the BLM's existing regulations for solar energy development.[2]

The BLM may choose to adopt one of the alternatives or a combination of alternatives; selected alternatives could also vary by geographic region. Combining alternatives could involve applying the concept of one of the more restrictive alternatives while changing the scope of the restriction to include lands available under one of the less restrictive alternatives.

Table ES-1 provides a summary description of the five Action Alternatives. Table ES-2 summarizes the BLM-administered lands available for application by state and in total for the No Action Alternative and each of the Action Alternatives. Alternative descriptions and maps showing areas available for application and excluded areas are provided in the following subsections. Note that the solar application areas given for each alternative in Table ES-2 are *estimates* of the actual areas available for application, because some types of exclusions could not be mapped for the planning effort.

[2] Amendments to the 2012 Western Solar Plan include addition of the Agua Caliente Solar Energy Zone (SEZ) in Arizona, the West Chocolate Mountain SEZ in California, the Dry Lake East DLA in Nevada, REDAs in Arizona, and solar emphasis areas in Colorado;, and deletion of the Fourmile East SEZ in Colorado, as detailed in Section 1.3.

Table ES-1. Summary Description of the Action Alternatives for the 11-State Planning Area

Action Alternative	Alternative 1 (Resource-Based Exclusions Only)	Alternative 2 (Resource-Based Exclusions and >10% Slope)	Alternative 3 (Transmission Proximity)	Alternative 4 (Previously Disturbed Lands)	Alternative 5 (Previously Disturbed Lands and Transmission Proximity)
What lands are available for application for solar energy development?	Solar application areas are all lands in 11-state planning area except for the excluded areas described below.	Solar application areas are lands in 11-state planning area except for the excluded areas described below.	Solar application areas are lands within 10 miles of existing and/or planned transmission lines ≥100 kV except for the excluded areas described below.	Solar application areas are previously disturbed lands (which have diminished resource integrity) except for the excluded areas described below.	Solar application areas are previously disturbed lands (which have diminished integrity) within 10 miles of existing and/or planned transmission lines ≥100 kV except for the excluded areas described below.
What lands are excluded from solar energy development?	No slope-based exclusion	**10% Slope Exclusion** applies to Alternatives 2-5 as a general resource protection measure.			
	Resource-Based Exclusion Criteria (Table 1.1-3) are applied to all Action Alternatives. For example, exclusion criteria would prohibit solar energy development in all designated and proposed critical habitat areas for species protected under the ESA or in BLM National Conservation Lands.				
What about remaining lands that are not solar application areas or excluded under resource-based exclusion criteria or the slope restriction?	Not applicable (no remaining lands)	Not applicable (no remaining lands)	No development outside of these areas. Remaining areas are excluded.		
Do design features apply to the solar application areas?	**Design Features are applied to all Action Alternatives**. Design features are project requirements incorporated into the alternatives to avoid, minimize, and/or compensate for adverse impacts. For example, an ecological design feature could require turning off all unnecessary lighting at night to limit attracting wildlife, particularly migratory birds.				

[a] The 11-state planning area consists of Arizona, California (excluding the DRECP area), Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

Table ES-2. BLM Land Use Allocations by Alternative[a,b]

Planning Area State	BLM Planning Area	No Action Alternative			Alternative 1		Alternative 2		Alternative 3			Alternative 4			Alternative 5		
		Priority Areas[b]	Lands Available for Application (variance areas in six-state area)[c]	Exclusion Areas	Lands Available for Application	Resource-Based Exclusion Areas	Lands Available for Applica-tion	Resource-Based Exclusion Areas	Lands Available for Application	Exclusion Areas: Resource-Based Exclusion Areas	Exclusion Areas: Additional Areas Not Meeting Transmis-sion Proximity Criteria	Lands Available for Application	Exclusion Areas: Resource-Based Exclusion Areas	Exclusion Areas: Additional Areas Not Meeting Disturbed-Lands Criteria	Lands Available for Application	Exclusion Areas: Resource-Based Exclusion Areas	Exclusion Areas: Additional areas Not Meeting Transmission Proximity or Disturbed-Lands Criteria
Arizona	12,109,337	198,948	2,861,429	9,048,960	4,886,293	7,223,044	3,285,400	8,823,937	2,292,321	8,861,753	955,263	887,183	8,823,937	2,398,218	725,628	8,861,753	2,521,955
California	4,150,345	0	117,933	4,032,412	1,145,205	3,005,140	220,088	3,930,257	157,698	3,932,003	60,664	116,417	3,930,257	103,671	89,258	3,932,003	129,084
Colorado	8,354,306	22,038	135,548	8,196,717	2,281,931	6,072,374	813,551	7,540,775	548,225	7,561,299	244,782	329,854	7,540,755	483,697	235,270	7,561,299	557,738
Idaho	11,774,992	0	7,055,043	4,719,949	2,650,929	9,124,063	1,835,601	9,939,392	1,473,202	10,005,023	296,767	942,187	9,939,392	893,414	866,830	10,005,023	903,139
Montana	8,043,025	0	4,011,886	4,031,139	1,229,774	6,813,252	715,863	7,327,163	209,796	7,328,457	504,772	513,232	7,327,163	202,631	149,389	7,328,457	565,179
Nevada	47,272,125	61,834	6,863,590	40,346,702	18,332,220	28,939,905	12,371,628	34,900,497	6,988,748	35,096,891	5,186,487	2,424,286	34,900,497	9,947,342	1,587,446	35,096,891	10,587,789
New Mexico	13,493,392	29,716	3,915,370	9,548,306	6,301,088	7,192,304	5,000,154	8,493,238	2,987,559	8,525,548	1,980,285	1,765,014	8,493,238	3,235,140	1,301,315	8,525,548	3,666,529
Oregon	15,718,197	0	10,965,383	4,752,813	2,553,861	13,164,335	1,125,451	14,592,746	714,957	14,611,765	391,475	408,071	14,592,746	717,380	308,340	14,611,765	798,093
Utah	22,767,896	17,659	1,815,742	20,934,494	9,883,743	12,884,153	6,562,857	16,205,038	3,768,382	16,273,746	2,725,767	1,938,117	16,205,038	4,624,740	1,570,779	16,273,746	4,923,370
Washing-ton	437,237	0	412,062	25,175	355,229	82,008	125,135	312,103	106,458	312,103	18,676	94,975	312,103	30,159	81,211	312,103	43,923
Wyoming	18,047,498	0	9,139,769	8,907,717	5,417,541	12,629,957	4,124,996	13,922,502	2,980,130	13,971,708	1,095,661	1,779,148	13,922,502	2,345,848	1,444,249	13,971,708	2,631,541
TOTAL	162,168,351	330,195	47,293,756	114,544,384	55,037,816	107,130,534	36,180,723	125,987,628	22,227,475	126,480,296	13,460,580	11,198,484	125,987,629	24,982,238	8,359,715	126,480,295	27,328,341

[a] All areas are in acres; all alternatives exclude lands subject to the California DRECP (approximately 27 million acres). The total acres associated with the resource-based exclusions differ slightly for Alternative 2 and Alternatives 3–5. This difference occurs because parcels 20 acres or smaller are not included in the calculation. When exclusions are applied under Alternatives 3–5, certain parcels that were identified as larger than 20 acres for Alternative 2 are split, resulting in a small difference in the calculated resource-based exclusion areas.

[b] Lands allocations are best estimates. The geographic boundaries for exclusion categories will change over time as land use plans are revised or amended and new information on resource conditions is developed.

[c] The No Action Alternative includes SEZs as amended, REDAs (Renewable Energy Development Areas; BLM 2013a), Solar Emphasis Areas in Colorado (BLM 2015), and the Dry Lake East Designated Leasing Area (DLA; BLM 2019a). The total priority area in each state has been updated to reflect changes implemented since 2012 (see Section 1.3). Under Alternatives 1 through 5, the priority areas are the same as under the No Action Alternative, except that the Los Mogotes SEZ in Colorado and the REDAs have been removed.

[d] Lands available for application under the No Action Alternative include existing variance lands in Arizona, California, Colorado, Nevada, New Mexico, and Utah. In Idaho, Montana, Oregon, Washington, and Wyoming, which were not part of the Western Solar Plan, lands available include all lands that are not otherwise excluded in existing land use plans.

ES.2.4.1 Action Alternatives

Each of the five Action Alternatives would amend resource management plans to identify BLM-administered lands available for or excluded from application for utility-scale solar energy development in the 11-state planning area (see Appendix A for a list of the proposed plan amendments associated with this Programmatic EIS). Under all Action Alternatives, a proposed ROW would only be approved following an appropriate project-specific review, and a decision to issue a ROW would need to comply with NEPA (see Section 1.1.5).[3] Any utility-scale solar application that includes areas located *within an exclusion area* would require a land use plan revision or amendment prior to approval. The proposed plan amendments associated with this Programmatic EIS would also update programmatic design features and the land use allocations for variance lands and the variance process under the Western Solar Plan would be removed and eliminated, respectively.

Alternative 1: Resource-Based Exclusion Criteria Only

Under Alternative 1, the BLM would identify BLM-administered lands in the 11-state planning area as either available for or excluded from application. The basis for excluding lands would be to protect known areas of importance for many different cultural, environmental, or other resources from the impacts of solar energy development. The specific categories of lands that would be excluded from solar energy application (i.e., the resource-based exclusion criteria) are listed in Section ES.2.4.1.1.

The remaining BLM-administered lands in the planning area would be available for utility-scale solar ROW application under the conditions specified in the ROD for this Solar Programmatic EIS (for example, implementation of design features would be required). Alternative 1 would make approximately 55 million acres across the 11-state planning area available for utility-scale ROW application. Figure ES-1 at the end of this section provides a map showing Alternative 1 land designations.

Alternative 2: Resource-Based Exclusion Criteria and >10% Slope Lands Excluded

As in Alternative 1, BLM-administered lands would be excluded from utility-scale solar energy application under the resource-based exclusion criteria identified in Table 2.1-3. In addition, lands with greater than 10% slope would be excluded under this alternative.

Although the BLM is not including a technology-based slope exclusion for any of the Action Alternatives, the BLM received extensive comments during the scoping process for the Programmatic EIS supporting the retention of a slope exclusion criterion to avoid resource impacts such as increased erosion and impacts on cultural resources, surface hydrology, Tribal interests, visual resources, and wildlife and wildlife movement. In light of these concerns regarding elimination of the slope criterion, the BLM proposes to

[3] A project includes the PV solar energy facility, supporting facilities, and transmission connections, and may be permitted under one or several ROWs.

retain a criterion for all alternatives except Alternative 1. Consistent with many comments, the BLM proposes to set that limitation at 10%.

Alternative 2 responds to comments that suggested BLM-administered lands should either be open or closed and that the BLM should not seek to identify more precisely the areas available for solar applications (like the SEZs). Alternative 2 takes a similar approach to Alternative 1, but protects substantially more land by applying a general resource-based slope exclusion (i.e., lands with >10% slope would be excluded), which avoids impacts potentially associated with development on higher slopes. Alternative 2 would make approximately 36 million acres across the 11-state planning area available for utility-scale ROW application. Figure ES-2 at the end of this section provides a map showing Alternative 2 land designations.

Alternative 3: Transmission Proximity

Alternative 3 focuses on proximity to transmission infrastructure and is the BLM's preferred alternative (see Section 2.5). As under Alternative 2, lands would be excluded from utility-scale solar energy application under resource-based exclusion criteria identified in Table 2.1-3 and a general resource-based slope exclusion (>10% slope). Solar application areas would be identified as remaining areas within 10 miles on both sides of existing and planned transmission lines with capacities of 100 kV or greater.[4,5] Solar application areas would also include areas proximate to (i.e., within 10 miles of) the centerline of most Section 368 energy corridors (for further discussion, see Appendix J, Section J.1.5.1). Remaining BLM-administered lands farther than 10 miles from these transmission lines would not be available for solar applications.

Many solar projects sited on public lands are located in proximity to (less than 3 miles from) existing or planned transmission line infrastructure. Alternative 3 would facilitate co-locating rights-of-way to prevent transmission infrastructure sprawl across public lands while also limiting impacts on resources. This alternative would allow future utilization of additional transmission capacity that may become available. The BLM considered also including lands in proximity to substations (existing and planned) in this alternative but determined that including substations would be redundant with simply framing the alternative in terms of proximity to transmission lines because substations are generally located close to transmission lines.

If the BLM were to receive a proposal for a solar project further than 10 miles from existing or planned transmission (thus in an exclusion area under this alternative), the BLM would still have the discretion to consider the proposed solar project (and any associated transmission infrastructure) through evaluation of a land use plan

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[4] Planned transmission line projects that cross BLM-administered lands (as listed in Appendix J, Table J-5) and areas within 10 miles of Section 368 corridors designated to accommodate aboveground development (except for Corridors of Concern; see Section J.1.5.1) are included.

[5] Transmission capacity is the amount of electricity that can be transmitted along a single line. Lower-capacity lines are less efficient, losing more power when transporting electricity over longer distances. Transmission lines with capacities less than 100 kV are relatively minor components of the transmission grid (NERC 2018).

amendment that would make available for solar energy application any necessary land not already available. The BLM will review solar energy development right-of-way applications for land use plan conformance. In cases where solar energy development proposals are not in conformance with an existing BLM land use plan adopted as part of this alternative because the project site is not within 10 miles of transmission, the BLM may choose to amend the existing land use plan concurrently with processing the application using the same environmental review process. Solar energy development applications that would require minor amendments to identify the specific site as suitable for utility-scale solar energy development may be permissible; however, processing of solar energy development applications that would require major land use plan revisions will be avoided.

If new transmission lines not currently anticipated are approved by the BLM in the future, the BLM could choose to amend relevant land use plans to make lands within a 10-mile proximity to the transmission line right-of-way available for solar applications absent any other compelling resource exclusion criteria. The BLM expects that the lead office processing the transmission right-of-way application could leverage this Programmatic EIS, once finalized, by either supplementing it or tiering to it in the course of NEPA analysis to support such an amendment.

The intent of this alternative is to focus applications into areas near existing or planned transmission lines and energy load centers while still protecting high-value resources, thus reducing habitat fragmentation, natural resource disturbance, and environmental and cultural resource impacts. This alternative responds to the extensive public comment stating that areas must be near transmission resources to be viable for development while excluding and thereby preserving for other uses areas less desirable for development. Alternative 3 would make approximately 22 million acres across the 11-state planning area available for utility-scale ROW application. Figure ES-3 at the end of this section provides a map showing Alternative 3 land designations.

Alternative 4: Previously Disturbed Lands

Alternative 4 focuses on previously disturbed lands. As under Alternatives 2 and 3, lands would be excluded from utility-scale solar energy application under resource-based exclusion criteria listed in Table 2.1-3 and a general resource-based slope exclusion (>10% slope).

Solar application areas would be remaining areas identified as previously disturbed lands, which generally have diminished resource integrity based on the U.S. Geological Survey (USGS) Landscape Intactness model (Carter et al. 2017). In addition to the resource exclusion criteria under all alternatives, this alternative utilizes the USGS study, combined with data related to herbaceous vegetation cover, to develop a macro-scale strategy to avoid and minimize potential adverse consequences of development on public lands. Under this alternative, the BLM would allocate solar application areas where previously disturbed lands have been identified on the basis of a substantial departure from baseline resource conditions according to the USGS Landscape Intactness model, or where the presence of invasive annual weeds at pixel densities greater than 40% is estimated based on the general assumption that lands with invasive weeds at this level or greater would encounter substantial challenges to restoration. Lands with less than 40% annual weed cover would be excluded from solar energy development, thereby preserving these lands for potential future restoration, as appropriate. Annual herbaceous cover data prepared by the Multi-Resolution Land Characteristics (MRLC) consortium are being used as a proxy for the degree of presence of invasive weeds (MRLC 2023). The BLM anticipates this alternative would result in more efficient application reviews and more environmentally responsible solar energy development, because development would be focused on disturbed or degraded lands and avoid sensitive resources.

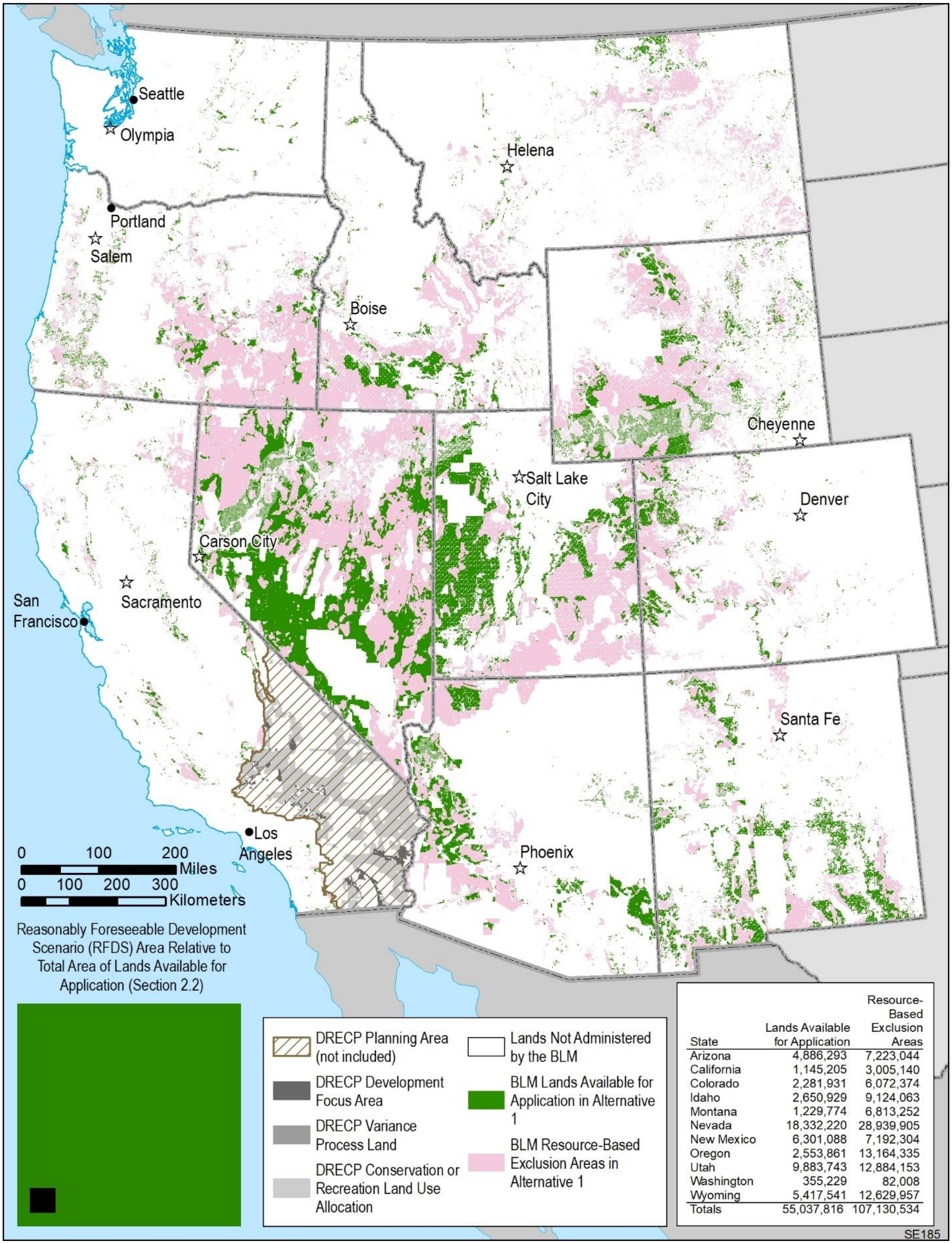
The intent of Alternative 4 is to limit impacts associated with utility-scale solar energy projects on undisturbed lands. Alternative 4 would make approximately 11 million acres across the 11-state planning area available for application. Figure ES-4 at the end of this section provides a map showing Alternative 4 land designations.

Alternative 5: Lands Previously Disturbed and Proximate to Transmission

Alternative 5 combines the focus of Alternatives 3 and 4 and identifies lands as available for solar application if they are both near transmission infrastructure and previously disturbed. As under Alternatives 2-4, lands would be excluded from utility-scale solar energy application under resource-based exclusion criteria listed in Table 2.1-3 and a general resource-based slope exclusion (>10% slope).

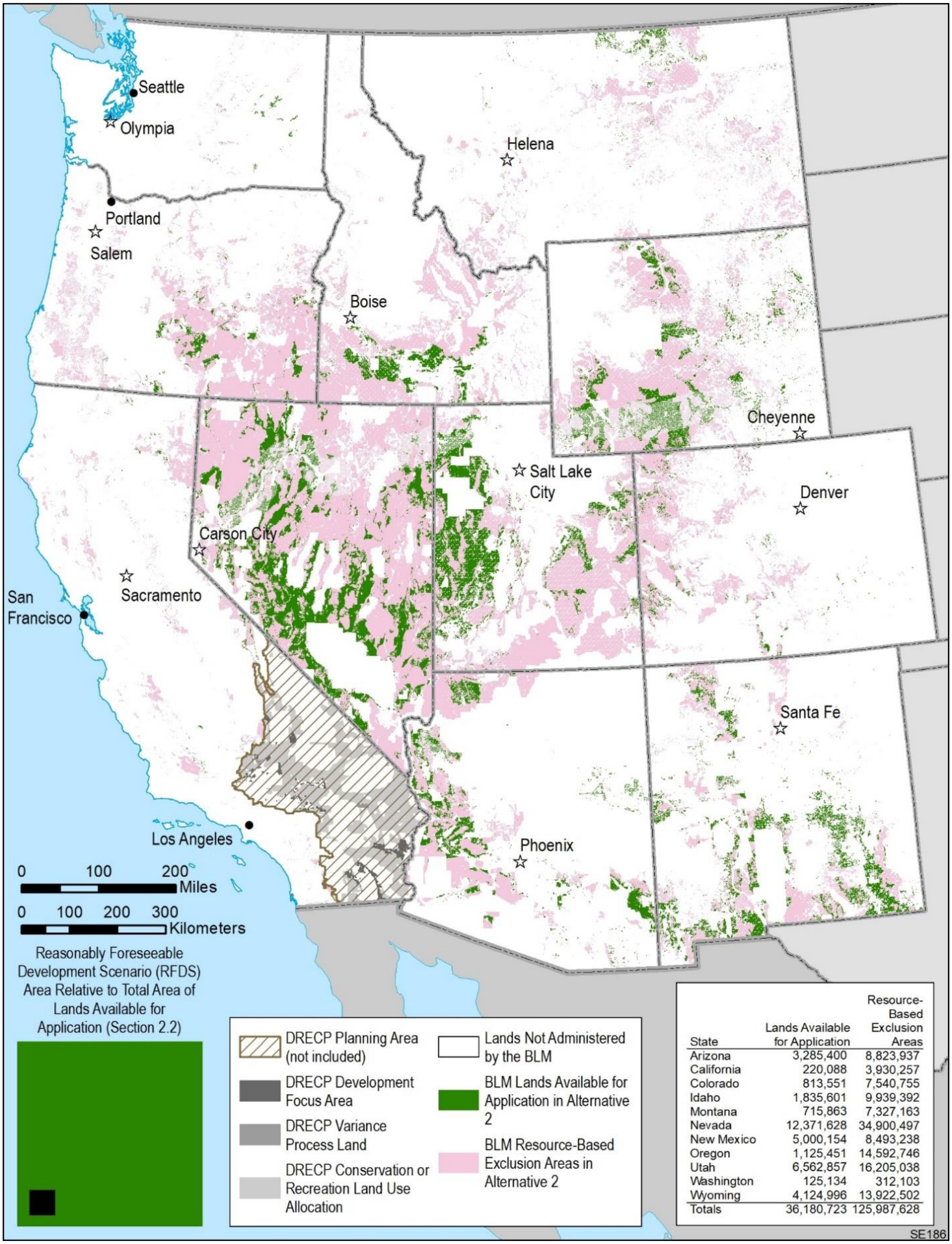
Solar application areas would be areas that are within (1) 10 miles of existing and planned transmission lines with capacities of 100 kV or greater (as described above for Alternative 3) and (2) previously disturbed (as described above for Alternative 4). Remaining lands that are more than 10 miles from transmission lines or have moderate or high intactness or invasive weeds present at less than 40% and not otherwise excluded would not be available for solar applications.

The intent of this alternative is to limit impacts associated with utility-scale solar energy projects to undisturbed lands, and to focus development into areas close to the transmission grid. This alternative combines the environmental benefits of Alternatives 3 and 4. Alternative 5 would make approximately 8 million acres across the 11-state planning area available for utility-scale ROW application. Figure ES-5 provides a map showing Alternative 5 land designations.



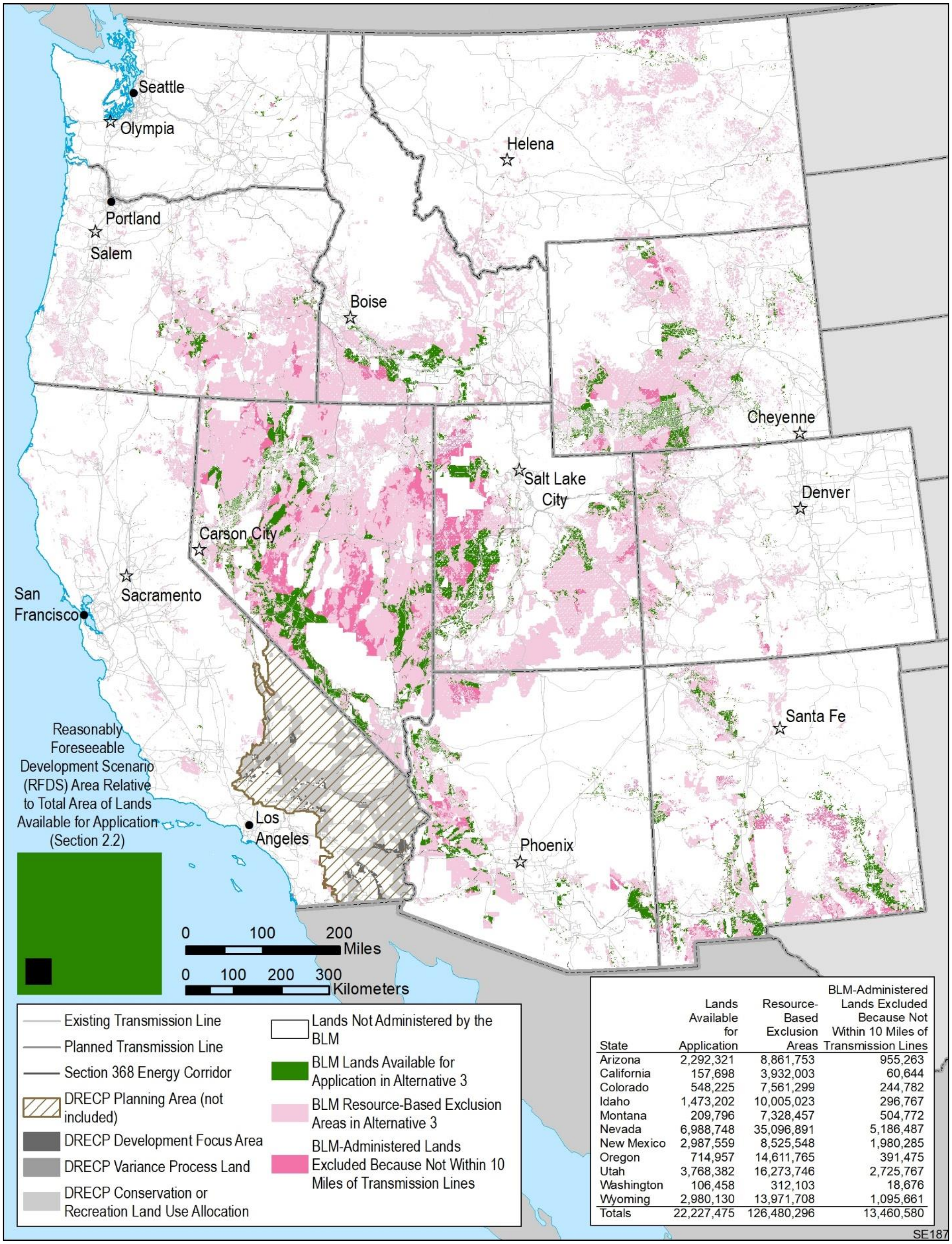
State	Lands Available for Application	Resource-Based Exclusion Areas
Arizona	4,886,293	7,223,044
California	1,145,205	3,005,140
Colorado	2,281,931	6,072,374
Idaho	2,650,929	9,124,063
Montana	1,229,774	6,813,252
Nevada	18,332,220	28,939,905
New Mexico	6,301,088	7,192,304
Oregon	2,553,861	13,164,335
Utah	9,883,743	12,884,153
Washington	355,229	82,008
Wyoming	5,417,541	12,629,957
Totals	55,037,816	107,130,534

Figure ES-1. BLM-Administered Lands Excluded and Available for Application in the 11-State Planning Area under Alternative 1.



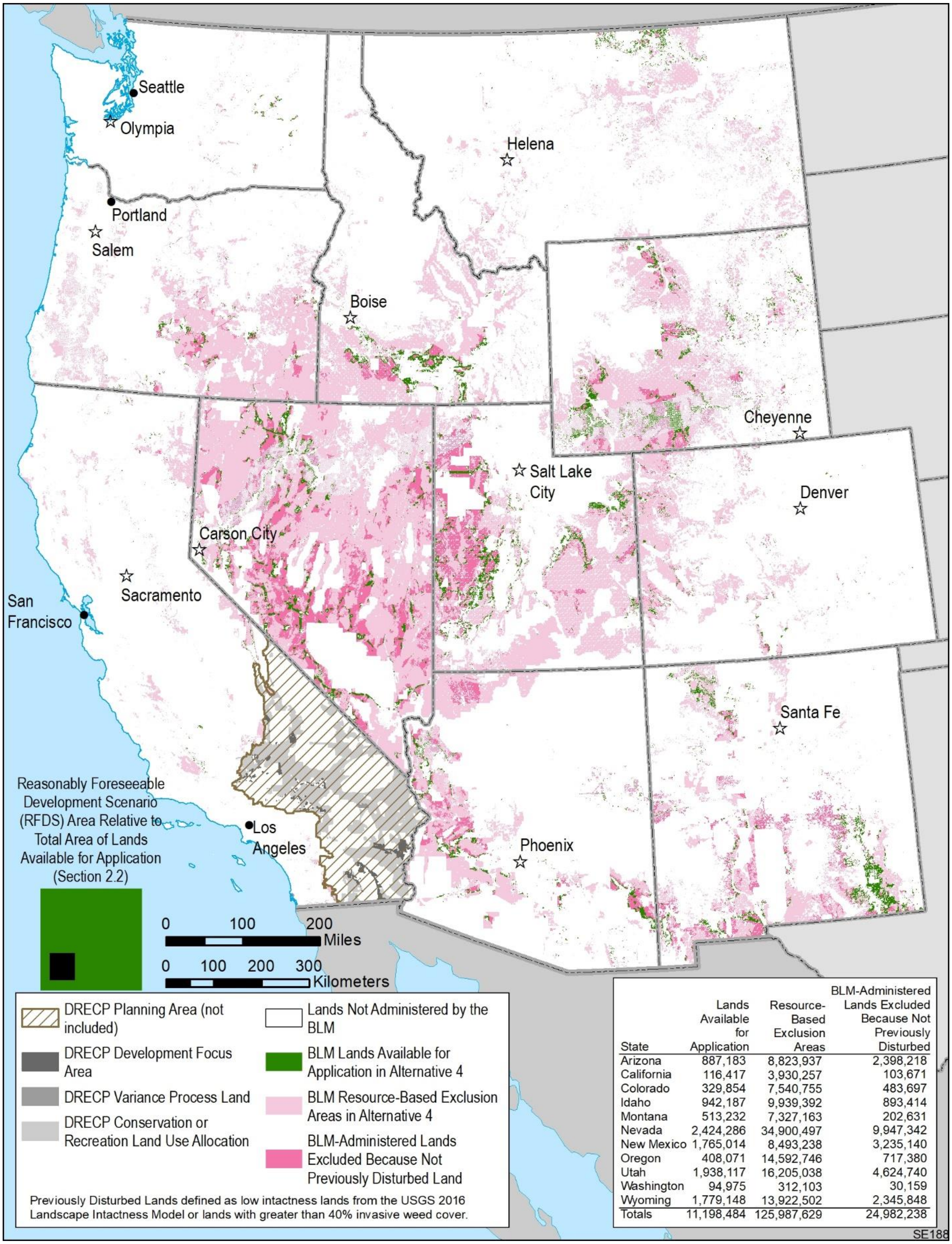
State	Lands Available for Application	Resource-Based Exclusion Areas
Arizona	3,285,400	8,823,937
California	220,088	3,930,257
Colorado	813,551	7,540,755
Idaho	1,835,601	9,939,392
Montana	715,863	7,327,163
Nevada	12,371,628	34,900,497
New Mexico	5,000,154	8,493,238
Oregon	1,125,451	14,592,746
Utah	6,562,857	16,205,038
Washington	125,134	312,103
Wyoming	4,124,996	13,922,502
Totals	36,180,723	125,987,628

Figure ES-2. BLM-Administered Lands Excluded and Available for Application in the 11-State Planning Area under Alternative 2.



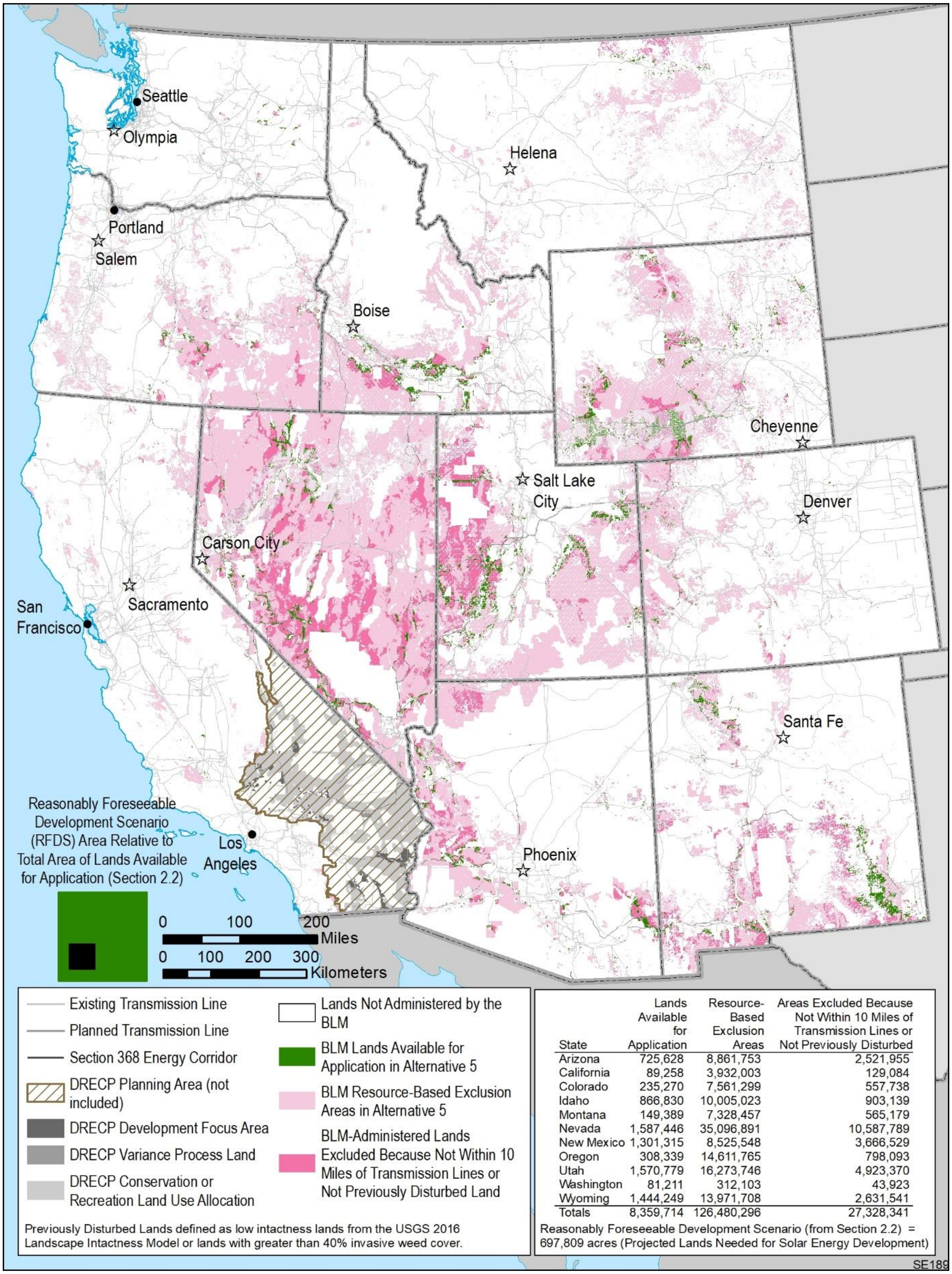
State	Lands Available for Application	Resource-Based Exclusion Areas	BLM-Administered Lands Excluded Because Not Within 10 Miles of Transmission Lines
Arizona	2,292,321	8,861,753	955,263
California	157,698	3,932,003	60,644
Colorado	548,225	7,561,299	244,782
Idaho	1,473,202	10,005,023	296,767
Montana	209,796	7,328,457	504,772
Nevada	6,988,748	35,096,891	5,186,487
New Mexico	2,987,559	8,525,548	1,980,285
Oregon	714,957	14,611,765	391,475
Utah	3,768,382	16,273,746	2,725,767
Washington	106,458	312,103	18,676
Wyoming	2,980,130	13,971,708	1,095,661
Totals	22,227,475	126,480,296	13,460,580

Figure ES-3. BLM-Administered Lands Excluded and Available for Application in the 11-State Planning Area under Alternative 3.



State	Lands Available for Application	Resource-Based Exclusion Areas	BLM-Administered Lands Excluded Because Not Previously Disturbed
Arizona	887,183	8,823,937	2,398,218
California	116,417	3,930,257	103,671
Colorado	329,854	7,540,755	483,697
Idaho	942,187	9,939,392	893,414
Montana	513,232	7,327,163	202,631
Nevada	2,424,286	34,900,497	9,947,342
New Mexico	1,765,014	8,493,238	3,235,140
Oregon	408,071	14,592,746	717,380
Utah	1,938,117	16,205,038	4,624,740
Washington	94,975	312,103	30,159
Wyoming	1,779,148	13,922,502	2,345,848
Totals	11,198,484	125,987,629	24,982,238

Figure ES-4. BLM-Administered Lands Excluded and Available for Application in the 11-State Planning Area under Alternative 4.



State	Lands Available for Application	Resource-Based Exclusion Areas	Areas Excluded Because Not Within 10 Miles of Transmission Lines or Not Previously Disturbed
Arizona	725,628	8,861,753	2,521,955
California	89,258	3,932,003	129,084
Colorado	235,270	7,561,299	557,738
Idaho	866,830	10,005,023	903,139
Montana	149,389	7,328,457	565,179
Nevada	1,587,446	35,096,891	10,587,789
New Mexico	1,301,315	8,525,548	3,666,529
Oregon	308,339	14,611,765	798,093
Utah	1,570,779	16,273,746	4,923,370
Washington	81,211	312,103	43,923
Wyoming	1,444,249	13,971,708	2,631,541
Totals	8,359,714	126,480,296	27,328,341

Reasonably Foreseeable Development Scenario (from Section 2.2) = 697,809 acres (Projected Lands Needed for Solar Energy Development)

Figure ES-5. BLM-Administered Lands Excluded and Available for Application in the 11-State Planning Area under Alternative 5.

ES.2.4.1.1 Exclusion Criteria Under the Action Alternatives

Under each of the Action Alternatives, lands would be excluded from solar energy application using various resource-based exclusion criteria, which are presented in Table ES-3. For this Solar Programmatic EIS, the exclusion criteria adopted under the Western Solar Plan have been reviewed and updated, taking into account BLM experience to date in permitting and monitoring PV solar energy facilities, as well as public and cooperating agency input.

Table ES-3. Proposed Resource-Based Exclusion Criteria Common to All Action Alternatives (see Table 2.1-3 for detailed footnotes)

Exclusion No.	Exclusion Type	Description
1	Areas of Critical Environmental Concern (ACECs)	All ACECs identified in applicable land use plans.
2	Threatened and Endangered Species	All designated and proposed critical habitat areas for species protected under the ESA (https://ecos.fws.gov/ecp/report/critical-habitat). Known occupied habitat for ESA-listed species, based on current available information or surveys of project areas.[b]
3	Lands with Wilderness Characteristics	All areas for which an applicable land use plan establishes protection for lands with wilderness characteristics.
4	Recreation	Developed recreational facilities and all Special Recreation Management Areas (SRMAs) identified in applicable land use plans .[c]
5	Habitat Areas	Dixie valley toad habitat, Wyoming toad habitat, and Carson wandering skipper habitat. All areas where the BLM has agreements with USFWS and/or state agency partners and other entities to manage sensitive species habitat in a manner that would preclude solar energy development, including habitat protection and other recommendations in conservation agreements/strategies.
6	Greater Sage-Grouse and Gunnison Sage-Grouse	Greater sage-grouse and Gunnison sage-grouse habitat as identified for exclusion in applicable land use plans.[d]
7	Land Use Designations	All areas designated as no surface occupancy (NSO) in applicable land use plans. All ROW exclusion areas identified in applicable land use plans. All ROW avoidance areas identified in applicable land use plans to the extent the purpose of the ROW avoidance is incompatible with solar energy development.
8	Desert Tortoise	All desert tortoise translocation sites identified in applicable resource management plans, project-level mitigation plans, or Biological Opinions.
9	Big Game	All big game migratory corridors identified in applicable land use plans to the extent the land use plan decision prohibits utility-scale solar energy development. All big game winter ranges identified in applicable land use plans to the extent the land use plan decision prohibits utility-scale solar energy development.
10	Natural Areas and Other Conservation Areas	Research Natural Areas and Outstanding Natural Areas identified in applicable land use plans.[e] All Backcountry Conservation Areas identified in applicable land use plans.
11	Visual Resources	Lands classified as visual resource management (VRM) Class I or II throughout the 11-state planning area and, only in Utah (and small parts of Arizona and Colorado), some lands classified as Class III[f] in applicable land use plans.

Exclusion No.	Exclusion Type	Description
12	National Scenic Byways	All National Scenic Byways, including all BLM Back Country Byways (BLM State Director approved) identified in applicable BLM land use plans, including any associated corridor or lands identified for protection through an applicable land use plan.
13	National Recreation, Water, or Side and Connecting Trails	All Secretarially designated National Recreation Trails (including National Water Trails) and Connecting and Side Trails identified in applicable BLM and local land use plans, including any associated corridor or lands identified for protection through an applicable land use plan.

14	National Conservation Lands	All units of BLM National Conservation Lands:
		• National Monuments
		• National Conservation Areas and other areas similarly designated for conservation, including Cooperative Management and Protection Areas, Outstanding Natural Areas,[e] Forest Reserves, and National Scenic Areas.
		• National Trails System
		  ◦ All National Scenic and Historic Trails designated by Congress, trails recommended as suitable for designation through a congressionally authorized National Trail Feasibility Study, or such qualifying trails identified as additional routes in law, including any trail management corridors identified for protection through an applicable land use plan,[g]
		  ◦ Trails undergoing a Congressionally authorized National Trail Feasibility Study will also be excluded pending the outcome of the study.
		• National Wild and Scenic Rivers:
		  ◦ All designated Wild and Scenic Rivers, including any associated corridor and lands identified for protection through an applicable river corridor plan (or comprehensive river management plan). Absent a river plan, protection corridors are ¼ mile to either side of the river from the ordinary high-water mark, unless otherwise provided by law.
		  ◦ Areas outside a designated wild and scenic river corridor when the project would "invade the area or unreasonably diminish" the wild and scenic river's river values.
		  ◦ All segments of rivers determined to be eligible or suitable for Wild or Scenic River status as identified in applicable land use plans, including any associated corridor and lands identified for protection through an applicable land use plan.
		• Wilderness Areas and Wilderness Study Areas

15	National Natural Landmarks	National Natural Landmarks identified in applicable land use plans, including any associated lands identified for protection through an applicable land use plan.
16	*National Register of Historic Places* (NRHP)	Lands within the boundaries of properties listed in the NRHP, including National Historic Landmarks, and any additional lands outside the designated boundaries identified for protection through an applicable land use plan.
17	Tribal Interest Areas	Traditional cultural properties (TCPs) and Native American sacred sites that are identified through consultation with Tribes and recognized by the BLM or that are the subject of a Memorandum of Understanding between the BLM and a Tribe or Tribes.
18	Old Growth Forests	Old Growth Forests identified in applicable land use plans.

Exclusion No.	Exclusion Type	Description
19	Lands Previously Found to Be Inappropriate for Solar Energy Development	Lands found to be inappropriate for solar energy development through a prior environmental review process.[h]
20	Acquired Lands	All lands acquired by the BLM using funds from the Land and Water Conservation Fund or the Southern Nevada Public Land Management Act, as amended (Public Law 105-263).
21	State- or Area-Specific	In Nevada, lands in the Ivanpah Valley, Coal Valley, and Garden Valley. Area surrounding Chaco Culture National Historical Park consistent with Public Land Order No. 7923. Rio Grande Natural Area (as established by Public Law 109-337).

ES.2.4.1.2 Design Features Under the Action Alternatives

The 2012 Western Solar Plan established design features applicable to all future utility-scale solar energy development on BLM-administered lands. Design features are project requirements that have been incorporated into the proposed action and other Action Alternatives to avoid, minimize, and/or compensate for adverse impacts. For this Programmatic EIS, the BLM reviewed the design features from the 2012 Western Solar Plan, taking into account BLM experience to date in permitting and monitoring PV solar energy facilities, as well as public and cooperating agency input, and updated them as appropriate. The proposed design features are presented in Appendix B by resource type and by project phase (i.e., general; site characterization, siting, design, and construction; operations and maintenance; and decommissioning/reclamation). These design features address resource conflicts associated with utility-scale solar energy development. In addition, projects on BLM-administered lands are required to follow all applicable federal, state, and local laws and regulations, such as the ESA, which will impose additional requirements that avoid and/or minimize resource impacts.

For those impacts that cannot be avoided or minimized, the BLM will consider implementing compensatory mitigation to offset impacts, with a goal of ensuring viability of resources over time.

ES.2.4.1.3 Monitoring and Adaptive Management

The BLM's Assessment, Inventory, and Monitoring (AIM) Strategy for condition and trend monitoring of BLM-managed resources and lands has been in use for several years (Taylor et al. 2014). A long-term monitoring strategy incorporating the AIM strategy was developed for the Riverside East SEZ (BLM 2016b). The BLM supports the use of the AIM Strategy as the basis for long-term solar monitoring and adaptive management. The AIM Strategy provides a replicable, consistent framework for collecting monitoring data and for adaptively managing the siting and permitting of solar energy projects. Further, an AIM-based project- or region-specific long-term monitoring plan can take advantage of guidance and support available from BLM's AIM staff (BLM 2023c). The information derived from monitoring of solar energy development will provide understanding of the condition and trend of BLM-managed lands within and near solar energy projects located on BLM-administered land and can support informed decision-making across jurisdictional boundaries.

ES.2.4.2 No Action Alternative

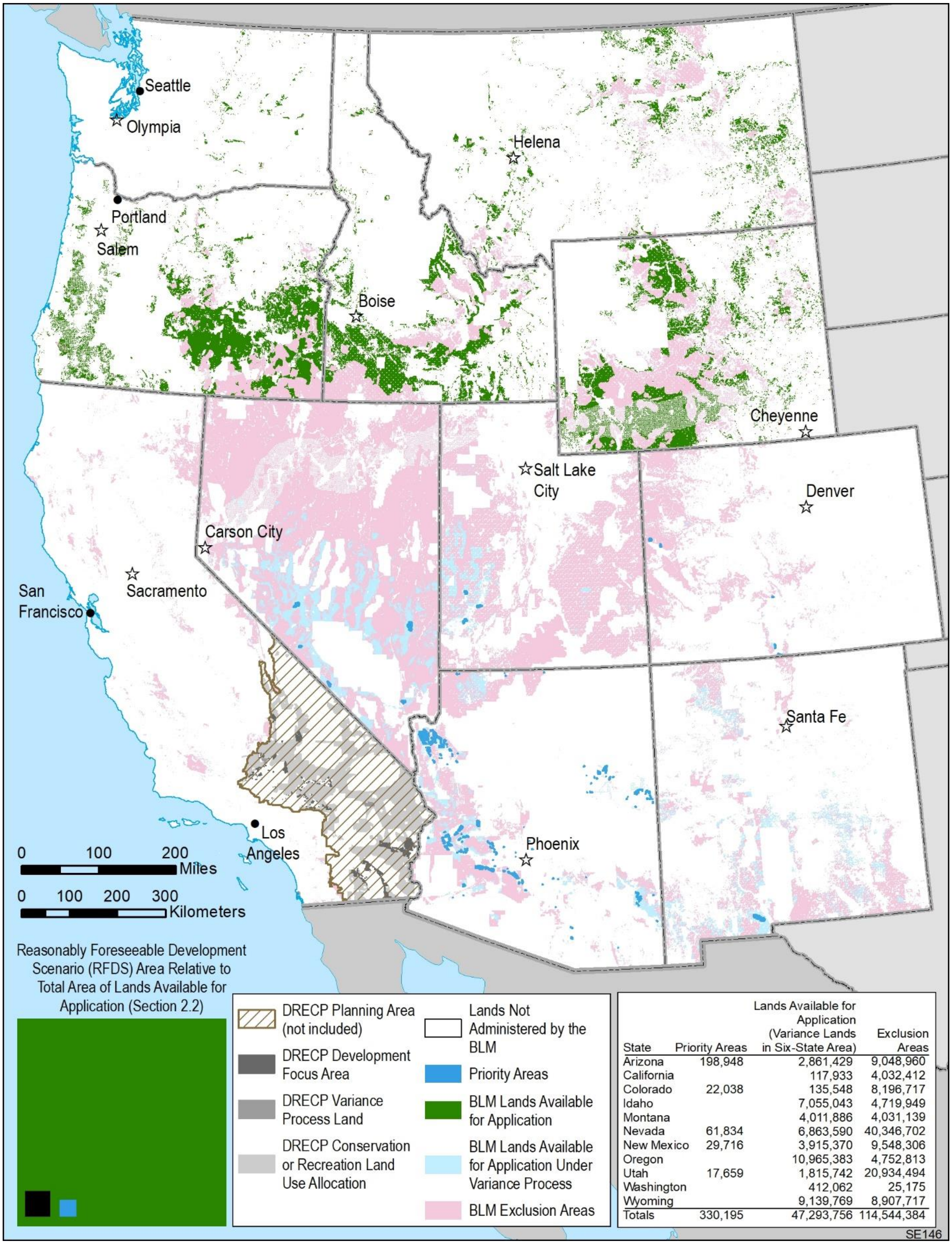
The No Action Alternative continues the management of utility-scale solar energy development in six southwestern states (Arizona, California, Colorado, Nevada, New Mexico, and Utah) as approved in the 2012 Western Solar Plan, as amended. That Plan excludes lands from utility-scale solar energy development, and designates SEZs as priority areas, specific locations well suited for utility-scale solar energy where the BLM prioritizes development.[6] The Western Solar Plan also allows for consideration of utility-scale solar energy development proposals on lands outside of SEZs in accordance with procedures in a variance process established in the plan decision. The Plan established programmatic design features for utility-scale solar energy development on BLM-administered lands. The Western Solar Plan amended the land use plans in the six-state planning area to reflect the identification of excluded lands, SEZs, and variance lands to facilitate permitting utility-scale (there defined as solar energy facilities with nameplate capacity of 20 MW or greater) solar energy generation projects. The specific categories of resource-based exclusions under the No Action Alternative are identified in Table 2.1-4. Additional exclusions are applied for lands with solar insolation levels less than 6.5 kWh/m^2/day and lands with slope >5%.

For the five states not subject to the Western Solar Plan, the No Action Alternative continues the status quo under which solar applications in those states are evaluated under the existing terms of approved resource management plans—for example, areas subject to an existing ROW exclusion are not available for solar applications.

ES.2.5 Reasonably Foreseeable Solar Energy Development Scenario

The BLM outlined a Reasonably Foreseeable Development Scenario (RFDS) projecting the amount of land area and electricity-generating capacity (power) requirements needed to support potential utility-scale solar energy development in the 11-state planning area through the year 2045 to inform this Programmatic EIS. The RFDS allows the BLM to evaluate whether the amount of land available for solar application under the alternatives would be adequate to meet the nation's renewable energy goals and anticipated development. Background and details on RFDS development are provided in Appendix C. The RFDS land use and power values presented in this section and Appendix C were used in the evaluations of the cumulative impacts of solar energy development on resources in the 11-state planning area that are presented in Chapter 5.

[6] Amendments to the 2012 Western Solar Plan include addition of the Agua Caliente SEZ in Arizona, the West Chocolate Mountain SEZ in California, the Dry Lake East DLA in Nevada, REDAs in Arizona, solar emphasis areas in Colorado; and deletion of the Fourmile East SEZ in Colorado, as detailed in Section 1.3.



State	Priority Areas	Lands Available for Application (Variance Lands in Six-State Area)	Exclusion Areas
Arizona	198,948	2,861,429	9,048,960
California		117,933	4,032,412
Colorado	22,038	135,548	8,196,717
Idaho		7,055,043	4,719,949
Montana		4,011,886	4,031,139
Nevada	61,834	6,863,590	40,346,702
New Mexico	29,716	3,915,370	9,548,306
Oregon		10,965,383	4,752,813
Utah	17,659	1,815,742	20,934,494
Washington		412,062	25,175
Wyoming		9,139,769	8,907,717
Totals	330,195	47,293,756	114,544,384

Figure ES-6. BLM-Administered Lands Designated as Priority Areas, Excluded, Variance, and Available for Application Under the No Action Alternative.

Table ES-4 presents an estimate of the amount of land required for solar energy development (the RFDS), including an estimate of the subset that would be developed on BLM-administered lands. State-level projections of solar energy development by 2045 are based on the DOE's *Solar Futures Study* (DOE 2021) and its companion report on environmental implications (NREL 2022). The BLM will continue to refine the RFDS, including in response to public comments. The Final Programmatic EIS, therefore, may include revisions to the RFDS and corresponding changes to the analysis of cumulative impacts and other aspects of the Programmatic EIS that rely on the RFDS.

Table ES-4. Reasonably Foreseeable Development Scenario[a]

State	Estimated Area Developed by 2045 Under RFDS (acres), by Landholding		Total State Land Area (acres)	BLM-Administered Land Area (% state total acres)
	BLM	Non-BLM		
Arizona	198,210	66,070	72,958,449	12,109,337 (17%)
California[b]	109,972	130,920	47,484,043	4,150,345 (6%)
Colorado	45,207	15,069	66,620,001	8,354,303 (13%)
Idaho	89,574	29,858	53,484,044	11,774,830 (22%)
Montana	5,387	1,796	94,105,196	8,043,026 (9%)
Nevada	48,119	16,040	70,757,520	47,272,125 (67%)
New Mexico	11,123	3,708	77,817,452	13,493,392 (17%)
Oregon	51,387	17,129	62,128,249	15,718,196 (25%)
Utah	39,793	13,264	54,334,651	22,767,896 (42%)
Washington	71,781	23,927	43,276,212	437,237 (1%)
Wyoming	27,255	9,085	62,600,125	18,047,487 (29%)
Total RFDS Acres	**697,809**	**326,685**	—	—

Sources: DOE (2021), NREL (2022).
[a] NREL (2022) estimates that a total of 1,307,493 acres of land in the 11-state planning area will be utilized for utility-scale solar energy development by 2045.
[b] To account for exclusion of the DRECP area in California, the proportion of BLM-administered lands outside of the DRECP area (28%) was applied to the estimated RFDS development acres. It is estimated that 282,786 acres of BLM-administered land within the DRECP planning area would be developed by 2045 under the RFDS.

ES.2.6 Summary Comparison of Alternatives

The comparison of impacts between alternatives described in Table ES-5 is based on the detailed discussion of the affected environment and impacts of solar energy development provided in this Programmatic EIS. Many of the impacts of utility-scale solar energy development are similar across the alternatives. However, the differing allocation and exclusion criteria across the alternatives results in differences in the amount of land available for application, along with differences in the locations of development.

Table ES-5. Comparison of Impacts Among Alternatives for Utility-Scale Solar Energy Development on BLM-Administered Lands

<table>
<tr><th>Resource</th><th>No Action Alternative</th><th>Alternative 1</th><th>Alternative 2</th><th>Alternative 3</th><th>Alternative 4</th><th>Alternative 5</th></tr>
<tr><td rowspan="2">Acoustic Environment (Section 5.1)</td><td colspan="6">Common impacts: Noise impacts may come from equipment used for land clearing, grading, site preparation, and construction, with the highest noise levels occurring during site preparation. Construction-related noise may adversely affect nearby residents and/or wildlife. Operations-related noise impacts would be less than construction-related impacts. Impacts from development to the RFDS level are expected to be low and similar under all alternatives.</td></tr>
<tr><td>Design features from the 2012 Western Solar Plan are required in six states; for five states mitigation is established on a project-specific basis.[a]</td><td colspan="5">Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.1) may reduce the magnitude of impacts in comparison with the No Action Alternative.</td></tr>
<tr><td rowspan="3">Air Quality (Section 5.2.1)</td><td colspan="6">Common impacts: Air quality would be adversely affected locally and temporarily during construction by fugitive dust and vehicle emissions, although impacts would be relatively minor. Operations would generally result in few air quality impacts, though for larger facilities with erodible soil and where vegetation has been removed fugitive dust emissions may cause substantial impacts.</td></tr>
<tr><td rowspan="2">Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis.[a]</td><td colspan="5">Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.2) may reduce the magnitude of impacts in comparison with the No Action Alternative.</td></tr>
<tr><td colspan="2">Impacts from development to the RFDS level are expected to be similar under Alternatives 1 and 2.</td><td colspan="3">Because lands available for application under Alternatives 3, 4 and 5 are restricted to areas that are close to existing or planned transmission and/or have been previously disturbed, those areas may be more distant from Federal Class I or other specially designated areas, and thus impacts may be reduced under these alternatives.</td></tr>
<tr><td>Climate Change (Section 5.2.2)</td><td colspan="6">Because greenhouse gas (GHG) emissions are aggregated across the global atmosphere and cumulatively contribute to climate change, climate change impacts are not particularly sensitive to the specific locations of GHG emissions within the lands available for application. Instead, the total level of solar energy development determines the GHG emissions caused and avoided. Very low GHG emissions are expected from solar energy development, most are associated with construction (particularly the use of heavy equipment and large on-road vehicles powered by diesel), along with a small contribution from small on-road vehicles powered by gasoline throughout the project. Positive impacts may occur if the generated solar energy replaces existing fossil fuel sources of energy, thus avoiding the GHG emissions from those fossil fuel sources. The emissions avoided if development reaches the RFDS level and the energy generated displaces fossil-fuel energy sources could be up to 123 million MT CO_2e/year, which represents about 51% of the 2021 annual GHG emissions from the electric power system in the 11-state planning area.</td></tr>
<tr><td rowspan="3">Cultural Resources (Section 5.3)</td><td colspan="6">Common impacts: Cultural resources are subject to loss during site preparation and construction, with potential impacts also possible during operations. Impacts could occur from clearing, grading, or excavation; alteration of topography or hydrologic patterns; erosion of soils; runoff and sedimentation; and/or contaminant spills. Additionally, increases in human access and associated disturbance would result from the establishment of facilities in otherwise intact and inaccessible areas. Visual and auditory degradation of settings associated with cultural resources could result from solar energy development and ancillary facilities. If a cultural resource is damaged or destroyed during development, that particular cultural location, resource, or object would be irretrievable. ACECs designated for cultural or historic resource values, National Historic and Scenic Trails, National Historic and Natural Landmarks are excluded from solar energy development, limiting direct impacts to cultural resources in these areas.</td></tr>
<tr><td>Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis.[a]</td><td colspan="5">Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.3) may reduce the magnitude of impacts in comparison with the No Action Alternative.</td></tr>
<tr><td>A total of 103,519 known cultural resources are located on lands available for application.</td><td>A total of 120,337 known cultural resources are located on lands available for application.</td><td>A total of 86,637 known cultural resources are located on lands available for application.</td><td>A total of 63,023 known cultural resources are located on lands available for application.</td><td>A total of 51,596 known cultural resources are located on lands available for application.</td><td>A total of 41,029 known cultural resources are located on lands available for application.</td></tr>
<tr><td rowspan="2">Vegetation (Section 5.4.1)</td><td colspan="6">Common impacts: Ground disturbance during construction may make vegetation communities more susceptible to noxious weed or invasive plant establishment. Construction also requires removal of vegetation from part or most of the solar facility area, which could result in substantial direct impacts in terms of increased risk of invasive species introduction; changes in species composition and distribution; habitat loss (e.g., dune or riparian areas); and damage to biological soil crusts. Indirect impacts include potential changes to the vegetation community with the formation of microclimates under the solar arrays, including changes in precipitation and shading.</td></tr>
<tr><td>Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis.[a]</td><td colspan="5">Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.4) may reduce the magnitude of impacts in comparison with the No Action Alternative.</td></tr>
</table>

Resource	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
	Primary ecoregions within the No Action Alternative area include the Northern Basin and Range and the Chihuahuan Desert.	Primary ecoregions within the Alternative 1 area include the Central Basin and Range and Chihuahuan Desert. The ecoregions with the greatest percentages of available lands are the Central Basin and Range (43%), the Wyoming Basin (9%), and the Colorado Plateau (7%).	Primary ecoregions within the Alternative 2 area include the Central Basin and Range and Chihuahuan Desert. The ecoregions with the greatest percentages of available lands are the Central Basin and Range (46%), the Wyoming Basin (10%) and the Chihuahuan Desert (9%).	Primary ecoregions within the Alternative 3 area include the Chihuahuan Desert and Central Basin and Range. The ecoregions with the greatest percentages of available lands are the Central Basin and Range (40%), the Wyoming Basin (12%), and the Chihuahuan Desert (10%).	Primary ecoregions within the Alternative 4 area include the Chihuahuan Desert and Snake River Plain. The ecoregions with the greatest percentages of available lands are the Central Basin and Range (31%), the Wyoming Basin (14%), and the Chihuahuan Desert (12%).	Primary ecoregions within the Alternative 5 area include the Chihuahuan Desert and Snake River Plain. The ecoregions with the greatest percentages of available lands are the Central Basin and Range (29%), the Wyoming Basin (15%), and the Chihuahuan Desert (12%)
Aquatic Biota (Section 5.4.2)	Common impacts: Depending on the location of the project, numerous aquatic species may be adversely impacted during construction, operations, and decommissioning by factors such as alteration of topography and drainage patterns, human presence, access, and activity, blockage of dispersal and movement, erosion, fugitive dust, groundwater withdrawal, habitat fragmentation, contaminant spills, vegetation clearing, and traffic. Ground disturbance associated with site characterization and construction activities can lead to increases in soil erosion that can increase sedimentation and turbidity in downgradient surface water habitats, and can lead to impacts on riparian and wetland habitats.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis.[a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.4) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
		Impacts from development to the RFDS level are expected to be similar under Alternatives 1, 2, and 3.			Alternatives 4 and 5 potentially avoid higher quality aquatic biota habitat by focusing future development on previously disturbed lands.	
Wildlife (Section 5.4.3)	Common impacts: Numerous wildlife species may be adversely impacted by solar energy development causing loss of habitat; disturbance; loss of food and prey species; loss of breeding areas; impacts on movement and migration; introduction of new species; habitat fragmentation; and changes in water availability. Construction and operation of transmission lines and/or meteorological towers can result in bird and bat mortality. The magnitude of impacts depends on the type, amount, and location of wildlife habitat that would be disturbed, the nature of the disturbance, the wildlife that occupy the area prior to construction, and the timing of construction activities relative to the crucial life stages of wildlife.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis.[a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.4) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
	10,993 acres (0.04%) of big game migration corridor[b] would overlap with priority areas and approximately 4.7 million acres (17.3%) of big game migration corridor would overlap with other lands available for application (including variance areas in six states under 2012 Western Solar Plan). 14,638 acres (0.03%) of big game winter habitat would overlap with priority areas and approximately 15.3 million acres (29%) would overlap other lands available for application (including variance areas in six states under 2012 Western Solar Plan).	Approximately 6.3 million acres (23%) of big game migration corridor would overlap with lands available for application. Approximately 12.8 million acres (24%) of big game winter habitat would overlap with lands available for application.	Approximately 3.1 million acres (11%) of big game migration corridor would overlap with lands available for application. Approximately 6.2 million acres (12%) of big game winter habitat would overlap with lands available for application.	Approximately 1.8 million acres (7%) of big game migration corridor would overlap with lands available application. Approximately 4 million acres (8%) of big game winter habitat would overlap with lands available for application. Keeping development in areas that are less than 10 miles from existing and planned transmission lines would limit development to wildlife habitat that may already be impacted by edge effects of transmission infrastructure.	Approximately 1 million acres (4%) of big game migration corridor would overlap with lands available for application. Approximately 2.4 million acres (5%) of big game winter habitat would overlap with lands available for application. Limiting development to previously disturbed lands potentially avoids higher quality habitat.	Approximately 730,000 acres (3%) of big game migration corridor would overlap with lands available for application. Approximately 1.8 million acres (3%) of big game winter habitat would overlap with lands available for application. Limiting development to previously disturbed lands and to areas that are less than 10 miles from existing or planned transmission potentially avoids higher quality wildlife habitat.
	Lands available for application in the five states not included in the 2012 Western Solar Plan are not constrained by slope. Thus, development in those states could occur on sloped land resulting in increased wildlife impacts.	Lands available for application would not be limited by slope. Thus, development could occur on sloped land resulting in increased wildlife impacts	Changing the slope exclusion criterion from 5% to 10% slope could result in greater wildlife impacts for Alternatives 2-5 in comparison with the No Action Alternative for the six states under the 2012 Western Solar Plan.			

Resource	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Special Status Species (Section 5.4.4)	Common impacts: Impacts would be similar to or the same as those for vegetation, wildlife, and aquatic biota (loss of habitat; disturbance; loss of food and prey species; loss of breeding areas; impacts on movement and migration; introduction of new species; habitat fragmentation; and changes in water availability). However, because of their small population sizes and often specialized habitat needs or dependence on rare habitats, SSS may be more vulnerable to impacts than common and widespread species. Small population size makes them more vulnerable to the effects of habitat fragmentation, habitat alteration, habitat degradation, human disturbance and harassment, mortality of individuals, and the loss of genetic diversity. Tables 5.4.4-1 to 5.4.4-3 quantify the numbers of SSS present in the 11-state planning area along with the numbers potentially affected by alternative.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis.[a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.4) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
	The priority areas available overlap with habitats of 48 ESA-listed species (11% of all ESA-listed species in the planning area). The other lands available (including variance areas in six states under 2012 Western Solar Plan) overlap with 408 ESA listed species (96% of all ESA listed species in the planning area). The lands available also overlap with high numbers of BLM-sensitive and State-listed species.	The lands available for application overlap with habitats of 375 ES-listed species (88% of all ESA-listed species in the planning area), along with high numbers of BLM-sensitive and State-listed species. This represents the greatest potential impact on SSS as compared to the other Action Alternatives.	The lands available for application overlap with habitats of 312 ESA-listed species (73% of all ESA-listed species in the planning area), along with high numbers of BLM-sensitive and State-listed species.	The lands available for application overlap with habitats of 300 ESA-listed species (71% of all ESA-listed species in the planning area), along with high numbers of BLM-sensitive and State-listed species.	The lands available for application overlap with habitats of 297 ESA-listed species (70% of all ESA-listed species in the planning area), along with high numbers of BLM-sensitive and State-listed species.	The lands available for application overlap with habitats of 287 ESA-listed species (68% of all ESA-listed species in the planning area), along with high numbers of BLM-sensitive and State-listed species. This represents the least potential impact on SSS as compared to the other action alternatives.
Environmental Justice (EJ) (Section 5.5)	Common impacts: Solar energy development has potential for EJ impacts where minority or low-income populations may be affected. Such impacts may derive from air pollution, noise, land use, cultural, or socioeconomic impacts. These impacts may be negative, as in the case of increased noise levels or altered land use patterns, or positive, as in the case of local or regional economic benefits resulting from increased jobs and revenue, and the potential displacement of as much as 123 million MT/year CO_2.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis.[a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.5) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
	The no action alternative area contains minority and/or low-income populations, including approximately 1.9 million individuals in low-income areas and approximately 900,000 individuals in minority areas.	The Alternative 1 area contains minority and/or low-income populations, including approximately 1.4 million individuals in low-income areas and approximately 580,000 individuals in minority areas.	The Alternative 2 area contains minority and/or low-income populations, including approximately 960,000 individuals in low-income areas and approximately 450,000 individuals in minority areas.	The Alternative 3 area contains minority and/or low-income populations, including approximately 900,000 individuals in low-income areas and 425,000 individuals in minority areas.	The Alternative 4 area contains minority and/or low-income populations, including approximately 900,000 individuals in low-income areas and approximately 400,000 individuals in minority areas.	The Alternative 5 area contains minority and/or low-income populations, including approximately 850,000 individuals in low-income areas and 400,000 individuals in minority areas.
Geology and Soil Resources (Section 5.6)	Common impacts: Development of large blocks of land for solar energy facilities and related infrastructure could result in substantial impacts to geologic and soil resources, potentially including farmland. Common impacts include soil compaction; soil horizon mixing; soil erosion and deposition by wind; soil erosion by water and surface runoff; sedimentation; and soil contamination.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis.[a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.6) may reduce the magnitude of impacts in comparison with the No Action Alternative.				

Resource	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
	Development on slopes greater than 5% is excluded, (for the six states under the 2012 Western Solar Plan) decreasing the potential for erosion of disturbed soils. Lack of any slope exclusion in the five states not addressed under the 2012 Western Solar Plan increases the potential for erosion of disturbed soils in comparison with the six states under the Western Solar Plan.	Lack of any slope exclusion would increase the potential for erosion of disturbed soils, as compared to the six states under the Western Solar Plan in the No Action Alternative and the other Action Alternatives.	Development on slopes greater than 10% would be excluded, reducing the potential for erosion of disturbed soils as compared to Alternative 1. The potential for soil erosion would increase in the six states under the 2012 Western Solar Plan, as compared to the No Action Alternative, because BLM-administered lands with a slope between 5 and 10% would be available for solar energy development.	As under Alternative 2, development on slopes greater than 10% would be excluded, reducing the potential for erosion of disturbed soils as compared to Alternative 1. Soil disturbance associated with transmission line development would potentially be reduced as compared to Alternatives 1 and 2 if fewer miles of transmission line development would occur due to the exclusion of lands greater than 10 miles from existing and planned transmission lines.	Development on slopes greater than 10% would be excluded, reducing the potential for erosion of disturbed soils similar to Alternatives 2 and 3.	Development on slopes greater than 10% would be excluded, reducing the potential for erosion of disturbed soils similar to Alternatives 2-4. Soil disturbance associated with transmission line development would potentially be reduced as compared to Alternatives 1, 2, and 4, if fewer miles of transmission line development would occur due to the exclusion of lands greater than 10 miles from existing and planned transmission lines.
	Approximately 8.4 million acres (17.7%) of available lands have a farmland classification. The projected area of development under the RFDS is about 1.4% of the available lands without farmland classification.	Approximately 5.2 million acres (9.4%) of available lands have a farmland classification. The projected area of development under the RFDS is about 1.4% of the available lands without farmland classification.	Approximately 4.6 million acres (12.7%) of available lands have a farmland classification. The projected area of development under the RFDS is about 2.2% of the available lands without farmland classification. This alternative could increase impacts to productive or potentially productive farmland compared to Alternative 1.	Approximately 2.8 million acres (12.5%) of available lands have a farmland classification. The projected area of development under the RFDS is about 3.6% of the available lands without farmland classification. This alternative could increase impacts to productive or potentially productive farmland compared to Alternatives 1 and 2.	Approximately 2 million acres (17.6%) of available lands have a farmland classification. The projected area of development under the RFDS is about 7.6% of the available lands without farmland classification. This alternative could increase impacts to productive or potentially productive farmland compared to Alternatives 1 through 3.	Approximately 1.4 million acres (16.3%) of available lands have a farmland classification. The projected area of development under the RFDS is about 10% of the available lands without farmland classification. This alternative could increase impacts to productive or potentially productive farmland compared to Alternatives 1 through 4.
Hazardous Materials and Waste (Section 5.7)	Common impacts: Impacts from the hazardous materials present during construction include increased risks of fires and contamination of environmental media from improper storage and handling, leading to spills or leaks. Impacts from development to the RFDS level are expected to be similar under all alternatives.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.7) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
Health and Safety (Section 5.8)	Common impacts: Impacts on health and safety from the development of solar energy facilities include occupational health and safety impacts (physical hazards, risks resulting from exposure to weather extremes, retinal exposures to high levels of glare, dust from construction activities, electrical shock, and exposures to hazardous substances, fire hazards, and the possibility of increased cancer risk if exposure to magnetic fields); public health and safety (physical hazards from unauthorized access, increased risk of traffic accidents, risk from public exposure to hazardous substances, and electrical hazards); natural events, and sabotage or terrorism. Impacts from development to the RFDS level are expected to be similar under all alternatives.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.8) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
Lands and Realty (Section 5.9)	Common impacts: Utility-scale solar energy development generally precludes other land uses within the project footprint and alters the character of largely open and undeveloped areas. Development of supporting infrastructure (e.g., new transmission lines, roads) also impacts local land use in the vicinity of the solar facility. Development has potential to fragment blocks of public land, creating isolated public land parcels which can be difficult to manage.					

Resource	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.9) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
		Impacts from development to the RFDS level are expected to be similar under Alternatives 1, 2, and 4.		Limiting development to within 10 miles of transmission lines may reduce impacts on land use by limiting the number and distance of any new transmission lines and ROWs.	Impacts from development to the RFDS level are expected to be similar under Alternatives 1, 2, and 4.	Limiting development to within 10 miles of transmission lines may reduce impacts on land use by limiting the number and distance of any new transmission lines and ROWs.
Military and Civilian Aviation (Section 5.10)	Common impacts: Impacts on aviation could occur if structures or equipment were positioned such that it would be a hazard to navigable airspace. Potential impacts could include safety concerns such as glare (reflectivity), radar interference, and physical penetration of airspace. Impacts from development to the RFDS level are expected to be similar under all alternatives.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.10) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
Minerals (Section 5.11)	Common impacts: Mining and extraction activities are affected by solar energy development ROW authorizations through reductions in acreage typically available for mineral extraction. Mineral development within the project ROW is generally an incompatible use; however, some resources underlying the project areas might be developable (e.g., through use of directional/horizontal drilling for oil and gas or geothermal resources, or underground mining). Lands within SEZs are withdrawn from location and entry under the mining laws. Lands within SEZs remain withdrawn from locatable mineral entry under the mining laws until 2032. (NOTE: In general, SEZ designations would remain unchanged under Alternatives 1-5, except that the Los Mogotes SEZ would no longer be a designated priority area.)					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.11) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
		Impacts from development to the RFDS level are expected to be similar under Alternatives 1, 2, and 3.			The restriction to use of disturbed lands could drive development to areas where more mineral operations leases already exist, making obtaining ROWs more difficult under Alternatives 4 and 5.	
Paleontological Resources (Section 5.12.1)	Common impacts: Paleontological resources can be adversely impacted by solar energy development ROW authorizations through degradation or destruction of the resource, loss of valuable scientific information, and increased human access and disturbance associated with clearing, grading, and excavation of project areas.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.12) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
	42,140 acres within priority areas are located within Potential Fossil Yield Classification (PFYC) Class 4 or 5; approximately 11.2 million acres of lands available for application (including variance areas in six states under 2012 Western Solar Plan) would be located within PFYC Class 4 (high) or 5 (very high), which represents 24% of the total lands available for application.	Approximately 10.2 million acres of land within areas available for application would be located within PFYC Class 4 or 5, which represents 19% of the total lands available for application.	Approximately 5.7 million acres of land within areas available for application would be located within PFYC Class 4 or 5, which represents 16% of the total lands available for application.	Approximately 4 million acres of land within areas available for application would be located within PFYC Class 4 or 5, which represents 18% of the total lands available for application.	Approximately 2.2 million acres of land within areas available for application would be located within PFYC Class 4 or 5, which represents 20% of the total lands available for application.	Approximately 1.7 million acres of land within areas available for application would be located within PFYC Class 4 or 5, which represents 20% of the total lands available for application.
Livestock Grazing (Section 5.13.1)	Common impacts: Until such time that cattle grazing under solar panels becomes feasible, grazing activities would likely be excluded from areas developed for utility-scale solar energy production. Livestock grazing allotments are affected by solar energy development ROW authorizations through reductions in acreage and/or loss of animal unit months.					

Resource	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.13) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
	Approximately 310,000 acres of grazing allotments are located within priority areas; approximately 42.8 million acres of grazing allotments are located in lands available for application (including variance areas in the six states under the 2012 Western Solar Plan).	Approximately 50.3 million acres of grazing allotments would be located within lands available for application, which represents 91% of the total lands available for application. Assuming development projected under the RFDS is evenly distributed within/outside of current grazing allotments, development is expected on approximately 1% of the total available grazing allotment area.	Approximately 32.2 million acres of grazing allotments would be located within lands available for application, which represents 89% of the total lands available for application. Assuming development projected under the RFDS is evenly distributed within/outside of current grazing allotments, development is expected on approximately 2% of the total available grazing allotment area.	Approximately 19.4 million acres of grazing allotments would be located within lands available for application, which represents 88% of the total lands available for application. Assuming development projected under the RFDS is evenly distributed within/outside of current grazing allotments, development is expected on approximately 3% of the total available grazing allotment area.	Approximately 9.9 million acres of grazing allotments would be located within lands available for application, which represents 88% of the total lands available for application. Assuming development projected under the RFDS is evenly distributed within/outside of current grazing allotments, development is expected on approximately 5% of the total available grazing allotment area.	Approximately 7.3 million acres of grazing allotments would be located within lands available for application, which represents 86% of the total lands available for application. Assuming development projected under the RFDS is evenly distributed within/outside of current grazing allotments, development is expected on approximately 7% of the total available grazing allotment area.
Wild Horses and Burros (WH&Bs) (Section 5.13.2)	Common impacts: Solar energy development may affect WH&B resource features (i.e., forage, water, cover, and space), individuals and populations, the continuance of a thriving natural ecological balance, and could result in reduction in herd management area (HMA) acreage, or affect the appropriate management level (AML) of a HMA.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.13) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
	106 acres of HMAs are located within priority areas, and approximately 5.6 million acres of HMAs are located within other lands available for application (including variance areas for six states under the 2012 Western Solar Plan), which represents approximately 22% of public land available for application.	Approximately 8.9 million acres of HMAs would be located within lands available for application, which represents 16% of the total land available for application.	Approximately 5 million acres of HMAs would be located within lands available for application, which represents 14% of the total land available for application.	Approximately 2.4 million acres of HMAs would be located within lands available for application, which represents 11% of the total land available for application.	Approximately 870,000 acres of HMAs would be located within lands available for application, which represents 8% of the total land available for application.	Approximately 500,000 acres of HMAs would be located within lands available for application, which represents 6% of the total land available for application. Because the development
Recreation (Section 5.14)	Common impacts: Recreational use would be excluded from all areas developed for solar energy facilities, including areas currently designated for OHV use. There may also be adverse impacts on recreational use of lands located nearby, including lands not administered by the BLM. Indirect impacts on recreational use would occur primarily on lands near the solar energy facilities and would result from the change in the overall character of undeveloped lands to an industrialized, developed area that would displace people who are seeking more rural or primitive surroundings for recreation. Changes to the visual landscape, impacts on vegetation, development of roads, and displacement of wildlife species resulting in reduction in recreational opportunities could degrade the recreational experience near where solar energy development occurs.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.14) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
	All SRMAs in the six states in the Western Solar Plan are excluded, except SRMAs in Nevada, which are available for application unless otherwise excluded. SRMAs in five states are not excluded.	All SRMAs in the 11-state planning area would be excluded from development. This could potentially reduce recreational impacts in comparison to the No Action Alternative.				

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<tr><th>Resource</th><th>No Action Alternative</th><th>Alternative 1</th><th>Alternative 2</th><th>Alternative 3</th><th>Alternative 4</th><th>Alternative 5</th></tr>
<tr><td></td><td>Within five states not addressed in the 2012 Western Solar Plan, all lands would be available for application, after application of any exclusions specified in applicable land use plans. Recreational use would be excluded from all developed areas.</td><td colspan="2">Impacts from development to the RFDS level are expected to be similar under Alternatives 1 and 2.</td><td>Limiting development to within 10 miles of transmission lines could reduce recreation impacts compared to Alternatives 1, 2, and 4, because generally shorter transmission lines would minimize adverse impacts to the recreational experience.</td><td>Limiting development to previously disturbed lands could result in avoiding intact areas where people recreate, in comparison with Alternatives 1-3.</td><td>Limiting development to within 10 miles of transmission lines could reduce recreation impacts compared to Alternatives 1, 2, and 4, because generally shorter transmission lines would minimize adverse impacts to the recreational experience.

Limiting development to previously disturbed lands could result in avoiding intact areas where people recreate, in comparison with Alternatives 1-3.</td></tr>
<tr><td rowspan="2">Socioeconomics (Section 5.15)</td><td colspan="6">Common impacts: Construction and operation of PV facilities could impact job creation, income, state tax income, in-migration, and government service costs. Impacts from development to the RFDS level are expected to be similar under all alternatives though the distribution of these impacts will be more concentrated in some alternatives.</td></tr>
<tr><td>Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]</td><td colspan="5">Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.15) may reduce the magnitude of impacts in comparison with the No Action Alternative.</td></tr>
<tr><td rowspan="4">Specially Designated Areas and Lands with Wilderness Characteristics (Section 5.16)</td><td colspan="6">Common impacts: Specially designated lands and lands with wilderness characteristics (LWCs) protected in applicable land use plans may be indirectly impacted (e.g., visual impacts, reduced access, and fugitive dust) during both the construction and operations phases.</td></tr>
<tr><td>Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]</td><td colspan="5">Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.16) may reduce the magnitude of impacts in comparison with the No Action Alternative.</td></tr>
<tr><td>Specially designated lands and lands with wilderness characteristics (as described under the Action Alternatives) are excluded from application in the six states addressed in the Western Solar Plan.</td><td colspan="5">NCLs are excluded from application, along with ACECs; Desert Wildlife Management Areas; National Recreation Trails and National Back Country Byways; Wild, Scenic, and Recreational Rivers, and segments of rivers determined to be eligible or suitable for Wild and Scenic River status. All areas where there is an applicable land use plan decision to protect LWCs are excluded.</td></tr>
<tr><td></td><td colspan="5">Impacts from development to the RFDS level are expected to be similar under Alternatives 1-5. Specially designated areas are excluded from solar energy development, but such areas near solar energy facilities could be adversely impacted. Impacts would depend on the characteristics of the solar energy facility and the proximity to specially designated areas.</td></tr>
<tr><td rowspan="3">Transportation (Section 5.17)</td><td colspan="6">Common impacts: Local road systems and traffic flow may be adversely impacted during construction for some projects. Impacts during operations are expected to be minor.</td></tr>
<tr><td rowspan="2">Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]</td><td colspan="5">Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.17) may reduce the magnitude of impacts in comparison with the No Action Alternative.</td></tr>
<tr><td colspan="2">Impacts from development to the RFDS level are expected to be similar under Alternatives 1 and 2.</td><td>Limiting development to areas within 10 miles of existing and planned transmission lines could limit traffic and road impacts to areas near existing roadways and access roads that have been developed for the nearby transmission lines.</td><td>Limiting development to previously disturbed lands could limit traffic and road impacts to areas near existing roadways and access roads that have been developed for other purposes.</td><td>Limiting development to previously disturbed lands and within 10 miles of existing and proposed transmission lines could limit traffic and road impacts to areas near existing roadways and access roads that have been developed for the nearby transmission lines or for other purposes.</td></tr>
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Resource	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Tribal Interests (Section 5.18)	Common impacts: Tribal resources are subject to loss during construction, but impacts are also possible during operations. Impacts could occur from land disturbance during construction and depend on the location of facilities. Impacts may include destruction of important locations, sacred or archaeologically significant sites, habitat for culturally important plants and wildlife species, increases in human access and subsequent disturbance, and visual resource degradation, and noise. TCPs and Native American sacred sites as identified through consultation with Tribes and recognized by the BLM are excluded.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.18) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
	The Los Mogotes SEZ in Colorado would remain in effect; solar energy development within the SEZ area would have high potential to cause significant impacts on Native American cultural and religious values.	The Los Mogotes SEZ in Colorado would be deallocated and the lands within the SEZ would no longer be available for utility-scale solar energy development. The deallocation of this SEZ would reduce the potential for future solar energy development to cause significant impacts on Native American cultural and religious values in this area.				
		Impacts from development to the RFDS level are expected to be similar under alternatives 1 and 2.		Limiting development to areas within 10 miles of existing and planned transmission lines could avoid new development in remote areas having Tribal significance and/or resources.	Limiting development to previously disturbed lands could avoid developing more remote lands that may have greater Tribal significance and/or resources.	Limiting development to previously disturbed lands and within 10 miles of existing and planned transmission lines could avoid new development in more remote lands that may have greater Tribal significance and/or resources.
Visual Resources (Section 5.19)	Common impacts: The construction and operation of utility-scale solar energy facilities may create visual contrasts with the surrounding landscape, primarily because they introduce large, complex, and visually distinctive human-made structures into existing landscapes. Visual impacts may include changes to visual values (e.g., scenic quality) and changes to the existing landscape character both as a result of the visual contrasts created by the facilities and public perception of those changes.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.19) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
	1% of the acres available are inventoried Scenic Quality Class A acres, 8% are Class B and 11% are Class C.	2% of the acres available are inventoried Scenic Quality Class A, 12% are Class B and 14% are Class C.	Less than 1% of the acres available are inventoried Scenic Quality Class A, 6% are Class B and 11% are Class C.	Less than 1% of the acres available are inventoried Scenic Quality Class A, 4% are Class B and 7% are Class C.	Less than 1% of the acres available are inventoried Scenic Quality Class A, 1% are Class B and 3% are Class C.	Less than 1% of the acres available are inventoried Scenic Quality Class A, 1% are Class B and 2% are Class C.
	Lands available for application in the five states not included in the 2012 Western Solar Plan are not constrained by slope. Thus, development in those states could occur on sloped land resulting in increased visual impact.	Lands available for application would not be limited by slope. Thus, development could occur on sloped land resulting in increased visual impact	Limiting development to slopes less than 10% would reduce the potential impacts because many sensitive visual resource areas (SVRAs) are in or near high-slope areas and because the larger viewing angle of solar facilities in high slope areas would mean greater visibility from valley floors, plains, other flat areas, and elevated viewing locations. Changing the slope exclusion criterion from 5% to 10% slope could result in greater impacts for Alternatives 2-5 in comparison with the No Action Alternative for the six states under the 2012 Western Solar Plan.			
	Lands available for application are not limited by transmission proximity or previous disturbance, and thus visual impacts would not be concentrated in areas that already have reduced scenic quality.	Lands available for application would not be limited by transmission proximity or previous disturbance, and thus visual impacts would not be concentrated in areas that already have reduced scenic quality.		Limiting development to within 10 miles of existing and planned transmission lines would reduce impacts because at shorter distances the presence of existing and planned transmission lines would have already reduced scenic quality or had impacts on nearby SVRAs.	Limiting development to previously disturbed lands would reduce impacts, because these lands would likely already have reduced scenic quality.	Compared to Alternatives 1–4, Alternative 5 would likely result in reduced impacts on scenic quality and SVRAs because it combines both impact reduction factors discussed for Alternatives 3 and 4.

Resource	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Water Resources (Section 5.20)	Common impacts: PV solar facilities require smaller volumes of water for panel washing and potable water uses than do other utility-scale solar technologies. Potential impacts include modification of surface and groundwater flow systems, water contamination resulting from chemical leaks or spills, and water quality degradation by runoff or excessive withdrawals. Impacts from development to the RFDS level are expected to be similar under all alternatives.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.20) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
Wildland Fire (Section 5.21)	Common impacts: Significant impacts could occur if wildland fire started at solar energy facilities, particularly in areas designated with high burn probability and CFWI (also known as the Fire Weather Index, FWI) values. Impacts from development to the RFDS level are expected to be similar under all alternatives.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.21) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
	In the last 20 years, California, Washington, and Idaho have been the most impacted by wildland fires; more than 20% of lands have had at least one wildland fire event. At least 10% of lands in Idaho and Washington have had at least two wildland fire events.	In the last 20 years, Washington, Idaho, and California have been the most impacted by wildland fires. Approximately 35% of lands available in Washington and 8% of lands available in Idaho and California have burned in wildland fire events. As these lands have burned within the last 20 years, there is a higher probability that they will burn again due to wildland fires.	In the last 20 years, Washington and Idaho have been the most impacted by wildland fires. Approximately 11% of lands available in Washington and 7% of lands available in Idaho have burned in wildland fire events. As these lands have burned within the last 20 years, there is a higher probability that they will burn again due to wildland fires.	In the last 20 years, Washington and Idaho have been the most impacted by wildland fires. Approximately 8% of the lands available in Washington and 5% of the lands available in Idaho have burned in wildland fire events. As these lands have burned within the last 20 years, there is a higher probability that they will burn again due to wildland fires.	In the last 20 years, Washington and Idaho have been the most impacted by wildland fires. Approximately 7% of the land available in Washington and 3% of the land available in Idaho have burned in wildland fire events. As these lands have burned within the last 20 years, there is a higher probability that they will burn again due to wildland fires.	In the last 20 years, Washington and Idaho have been the most impacted by wildland fires. Approximately 5% of land available in Washington and 2% of land available in Idaho have burned in wildland fire events. As these lands have burned within the last 20 years, there is a higher probability that they will burn again due to wildland fires.

[a] Design features established in the 2012 Western Solar Plan are only applicable to the six states within that planning area: Arizona, California, Colorado, Nevada, New Mexico, and Utah. These design features are not applicable to the five states addressed in this Solar Programmatic EIS that were not addressed in the 2012 Western Solar Plan (Idaho, Montana, Oregon, Washington, and Wyoming).

[b] Big game migration corridors as identified from USGS and currently applicable state agency sources.

ES.2.7 BLM's Preferred Alternative

The BLM has selected Alternative 3 as the preferred alternative for this Draft Solar Programmatic EIS.

Alternative 3's focus on lands proximate to transmission meets the BLM's objective of guiding applications for utility-scale solar energy development on BLM-administered lands to areas with generally lower resource conflicts that are also closer to potential transmission infrastructure connection. Proximity to transmission infrastructure is one of the most important site characteristics for successful utility-scale solar energy deployment. The resource-specific comparisons presented in Chapter 5 illustrates that Alternative 3 would generally avoid and minimize land disturbance, and reduce habitat fragmentation, resource degradation, and environmental and cultural resource impacts. Alternative 3 identifies lands as available for application where, based on its extensive solar permitting experience, the BLM expects to receive the majority of applications. Alternative 3 provides ample acreage needed to support estimated future development under the RFDS projections and helps fulfill the goals of the Energy Act of 2020, E.O. 14008, and E.O. 14057.

While Alternative 5 also focuses on lands proximate to transmission and includes more available land than the RFDS indicates will be needed for future solar development, Alternative 3 provides a larger margin of siting flexibility to avoid important resources and uses where the available public lands ultimately be determined unsuitable for solar energy development through site-specific environmental reviews. The BLM believes that the substantially larger amount of land available under Alternative 3 is needed to support future solar energy development and provide sufficient flexibility for solar energy developers to address potential local siting constraints and meet technical development requirements.

ES.3 Outreach and Engagement

The BLM's outreach efforts included publication of the NOI, distribution of news releases, public scoping meetings (both in-person and virtual), and informational letters to Tribes. The NOI to prepare this Programmatic EIS was published in the *Federal Register* (87 FR 75284) and the BLM's *National NEPA Register* on December 8, 2022. The BLM also sent informational letters to 241 federally recognized Tribes with affiliated lands within the 11-state planning area on December 5, 2022 (see Appendix D for details). These actions initiated the public scoping process for the Programmatic EIS.

The BLM hosted 15 public scoping meetings: 3 virtual and 12 in person (details provided in Section 6.1). The purpose of these meetings was to inform the public about the project and to provide an opportunity for individuals to submit oral comments. Of the 297 unique written submissions and 75 oral comments heard at the scoping meetings, and the BLM identified 2,026 unique comments. All scoping comment submittals were reviewed and categorized by individual topics addressed. Table 1-2 identifies the comment categories and percentage of comments in each category. In addition to unique submissions, more than 20,000 campaign letters sponsored by conservation and other organizations were received (see Section 6.1).

The scoping summary report and copies of comments were made available to the public in May 2023 through the BLM *National NEPA Register* (BLM 2023d).

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Acronyms and Abbreviations

AC	alternating current
ACEC	Area of Critical Environmental Concern
ac-ft	acre-foot (acre-feet)
ACHP	Advisory Council on Historic Preservation
ACS	American Community Service
AIM	Assessment, Inventory, and Monitoring (Strategy)
ALAN	artificial light at night
AML	appropriate management level
APE	area of potential effect
AQRV	air-quality-related value
AUM	animal unit month
BA	biological assessment
BESS	battery energy storage system
BGEPA	Bald and Golden Eagle Protection Act
BLM	Bureau of Land Management
BMP	best management practice
byway	National Scenic and Back Country Byway
°C	degree(s) Celsius
CAA	Clean Air Act
Cd	cadmium
CDCA	California Desert Conservation Area
CdTe	cadmium telluride
CEQ	Council on Environmental Quality
CFR	*Code of Federal Regulations*
CFWI	Canadian Forest Fire Weather Index
CH_4	methane
CIS	copper-indium-diselenide
CNEL	Community Noise Equivalent Level
CO	carbon monoxide
CO_2	carbon dioxide
CSP	concentrating solar power
CWA	Clean Water Act
Db	decibel(s)
Dba	A-weighted decibel(s)
DC	direct current
DLA	designated leasing area
DNI	direct normal irradiance
DNL, or L_{dn}	day-night average sound level
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy

DOI	U.S. Department of the Interior
DRECP	Desert Renewable Energy Conservation Plan
ECOS	Environmental Conservation Online System
EFFIS	European Forest Fire Information System
EIA	Energy Information Administration
EIS	Environmental Impact Statement
EJ	environmental justice
EMF	electromagnetic field
E.O.	Executive Order
EOL	end of life
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
ESA	Endangered Species Act of 1973 (as amended)
°F	degree(s) Fahrenheit
FAA	Federal Aviation Administration
FAST Act	Fixing America's Surface Transportation Act
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FLPMA	Federal Land Policy and Management Act of 1976
FR	*Federal Register*
ft	foot (feet)
g	acceleration due to gravity
gal	gallon(s)
GHG	greenhouse gas
GHGRP	Greenhouse Gas Reporting Program
GIS	geographical information system
GW	gigawatt(s)
GWP	global warming potential
H_2O	water
HA	herd area
HMA	herd management area
IBA	Important Bird Area
IDA	International Dark-Sky Association
IDSP	International Dark Sky Places
IM	Instruction Memorandum
IMPLAN	Economic Impact Analysis for Planning
in.	inch(es)
IRA	Inflation Reduction Act
ITA	Indian Trust Asset
JEDI	Jobs and Economic Development Impacts

kg	kilogram(s)
kHz	kilohertz
km	kilometer(s)
km^2	square kilometer(s)
Kw	kilowatt(s)
kWh	kilowatt-hour(s)
L	liter(s)
L_{dn} or DNL	day-night average sound level
L_{eq}	equivalent continuous sound level
L_p	sound pressure level
L_v	vibration velocity level
LULUCF	land use, land-use change, and forestry (also shown as clc)
LWC	lands with wilderness characteristics
m	meter(s)
m^2	square meter(s)
m^3	cubic meter(s)
MBTA	Migratory Bird Treaty Act
mcd/m^2	millicandellas per square meter
Mg	milliGauss
mi	mile(s)
mi^2	square mile(s)
MLA	Mineral Leasing Act of 1920
MMT CO_2e	million metric tons of CO_2 equivalent
MOA	Memorandum of Agreement
MT CO_2e	metric tons of CO_2 equivalent
MTR	military training route
MW	megawatt-hour(s)
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standard
NCL	National Conservation Land
NEPA	National Environmental Policy Act of 1969
NF_3	nitrogen trifluoride
NHPA	National Historic Preservation Act of 1966
NHT	National Historic Trail
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NREL	National Renewable Energy Laboratory
NRHP	*National Register of Historic Places*

NSC	National Safety Council
NSO	no surface occupancy
NST	National Scenic Trail
NWCC	National Wind Coordinating Committee
O_3	ozone
OHV	off-highway vehicle
OSHA	Occupational Safety and Health Administration
PARCA	Priority Amphibian and Reptile Conservation Area
Pb	lead
PFC	perfluorocarbon
PFYC	potential fossil yield classification
PHMA	Priority Habitat Management Area
PILT	payments in lieu of taxes
P.L.	Public Law
PM	particulate matter
$PM_{2.5}$	particulate matter with a diameter of 2.5 μm or less
PM_{10}	particulate matter with a diameter of 10 μm or less
PPA	Power Purchase Agreement
PPE	personal protective equipment
ppm	part(s) per million
PV	photovoltaic
RDEP	Arizona Restoration Design Energy Plan
RECO	Renewable Energy Coordination Office
REDA	Renewable Energy Development Area
RFDS	Reasonably Foreseeable Development Scenario
RMP	Resource Management Plan
ROD	Record of Decision
ROW	right-of-way
s	second(s)
SAAQS	State Ambient Air Quality Standard
SEZ	Solar Energy Zone
SF_6	sulfur hexafluoride
SFA	sagebrush focal area
SHPO	State Historic Preservation Office
SLRA	San Luis Resource Area
SO_2	sulfur dioxide
SRMA	Special Recreation Management Area
SRMS	Solar Regional Mitigation Strategy
SSS	special status species
SUA	special use airspace
SVRA	sensitive visual resource area

TCP	traditional cultural property
TerrADat	terrestrial indictors dataset
USC	*United States Code*
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VdB	vibration velocity decibel(s)
VOC	volatile organic compound
VRI	Visual Resource Inventory
VRM	Visual Resource Management
WH&B	wild horses and burros
WRCC	Western Regional Climate Center
WSA	Wilderness Study Area
WSR	Wild and Scenic River
yd^3	cubic yard(s)
yr	year(s)

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1 Introduction

The U.S. Department of the Interior (DOI) Bureau of Land Management (BLM) is undertaking a macro-scale evaluation of the potential environmental, cultural, and economic impacts of several modifications to its current solar energy program. These modifications are being considered to improve and expand the BLM's utility-scale solar energy planning in response to national priorities and goals for renewable energy development and changes in solar technologies since 2012. The modifications would update the *Approved Resource Management Plan Amendments/Record of Decision (ROD) for Solar Energy Development in Six Southwestern States* (BLM 2012a) (the "Western Solar Plan"), which applied to Arizona, California, Colorado, Nevada, New Mexico, and Utah; and would expand the BLM's solar energy planning to include Idaho, Montana, Oregon, Washington, and Wyoming. These states are collectively referred to as the 11-state planning area. The BLM has initiated and is preparing this *Programmatic Environmental Impact Statement (Programmatic EIS) for Utility-Scale Solar Energy Development* to analyze various alternatives for changes to land use allocations, permitting processes, and programmatic design features, and evaluate the environmental, cultural, and economic impacts of those potential changes. The Notice of Intent (NOI) to prepare this Programmatic EIS and amend RMPs was published in the *Federal Register* on December 8, 2022 (87 FR 75284).

The Western Solar Plan established land use allocations and rogramatic design features and implemented solar energy policies, procedures, and land use plan amendments related to permitting utility-scale solar energy developments on BLM-administered lands in six southwestern states. For these six states, the Western Solar Plan identified lands to be excluded from utility-scale solar energy development (approximately 79 million acres), and specific locations well suited for utility-scale solar energy where the BLM prioritizes development (i.e., Solar Energy Zones, or SEZs; approximately 285,000 acres). The Western Solar Plan also allowed for consideration of utility-scale solar energy development proposals on lands outside of SEZs (approximately 19 million acres, called "variance lands") in accordance with procedures in a variance process established in the plan decision, and established programmatic design features (required best management practices [BMPs]) for utility-scale solar energy development on BLM-administered lands. The Western Solar Plan amended the land use plans in the six-state planning area to reflect the identification of excluded lands, SEZs, and variance lands.

The 11-state planning area includes approximately 162 million acres of lands that are administered by the BLM under principles of multiple use and sustained yield, consistent with the Federal Land Policy and Management Act of 1976, as amended (FLPMA). Under FLPMA, the BLM strives to make land use decisions that meet the nation's many needs, are environmentally responsible, and take into account the use and enjoyment of the public lands by present and future generations. The BLM seeks to advance its solar energy program consistent with balanced management for important values (such as recreational use, agricultural use, and other energy development) and resources protection, including National Monuments and National Conservation Areas;

wilderness areas and wilderness study areas; other specially designated areas; wildlife and big game; water resources; and cultural, historic, and paleontological resources; as well as the restoration of lands and resources where appropriate.

This Utility-Scale Solar Energy Programmatic EIS evaluates the environmental, social, and economic impacts of the agency's proposed action and alternatives in accordance with the National Environmental Policy Act (NEPA), the Council on Environmental Quality's regulations for implementing NEPA (Title 40, Parts 1500–1508 of the *Code of Federal Regulations* [40 CFR Parts 1500–1508]), and applicable BLM and DOI authorities.[1] Programmatic NEPA analyses are broadly scoped analyses that assess the environmental impacts of federal actions across a span of conditions, such as facility types, geographic regions, or multi-project programs. As such, this Programmatic EIS considers the impacts of utility-scale solar energy development across a broad region (the 11-state planning area) and time frame (over approximately the next 20 years) to support the BLM's decision-making to facilitate environmentally sound solar energy development.

The following sections provide background information about the BLM's process for permitting solar energy facilities; the objectives and scope of this analysis; the scoping activities conducted for this Programmatic EIS; and the relationship of the proposed programs and strategies evaluated in this Programmatic EIS to other programs, policies, and plans.

1.1 Background and Purpose and Need

BLM-administered lands cover vast areas and have the potential to support substantial contributions to meeting the nation's energy needs. To promote the use of solar energy sources, the BLM considers and, where appropriate, approves applications for environmentally sound development of renewable energy on BLM-administered lands.

The efficient review of energy development proposals is an important component in achieving national energy goals. Power from solar, wind, and geothermal energy development on BLM-administered lands contributes to meeting the nation's energy needs. As of December 2022, the BLM had permitted over 9 GW of solar energy development (BLM 2023a), 3 GW of wind energy development, and 1.6 GW of geothermal energy development on BLM-administered lands. Additionally, as of May 2023 the BLM had also permitted 17 transmission connections (i.e., generation-ties or gen-ties) crossing BLM-administered lands to connect renewable energy projects on lands not administered by the BLM to existing electricity transmission (BLM 2023b). Department of Energy (DOE) forecasts indicate that solar energy development across the United States will continue to increase rapidly over the next several decades (DOE 2021).

[1] For the BLM, these authorities include the BLM's NEPA Handbook (BLM 2008a); DOI's NEPA Implementing Procedures, 43 CFR Part 46; and Chapter 11 of the DOI's Departmental Manual (DOI 2020).

1.1.1 BLM's Purpose and Need

The purpose of the proposed action is to facilitate improved siting of utility-scale solar energy development by identifying areas of BLM-administered lands where solar energy development proposals may encounter fewer resource conflicts than in other areas as "solar application areas", and identifying areas of BLM-administered lands with known high potential for resource conflicts as "exclusion areas". There is a need to improve the solar development application process by providing development opportunities in specified solar application areas while maintaining sufficient flexibility to account for site-specific resource considerations on a case-by-case basis under subsequent project-specific NEPA analysis. Although additional site-specific environmental analysis will be needed to support future project-level decisions to authorize utility-scale solar energy development, this macro-scale programmatic land use planning effort will provide a framework for making those decisions in a systematic and consistent way. Applications processed under this framework are expected to have a higher likelihood of alignment with the BLM's multiple use and sustained yield mission than under the Western Solar Plan, leading to more expedient processing without jeopardizing critical resources or other uses of BLM-administered lands.

This programmatic planning effort also provides updates that respond to changes that have occurred over the 11 years since the BLM issued the Western Solar Plan. First, utility-scale solar energy development on and off BLM-administered lands has significantly increased and is expected to continue to increase in view of a growing public interest in carbon pollution-free energy generation. Second, due to technological advancements as well as economic forces affecting power markets, the composition of proposed solar energy generation projects is now different, with more focus by solar developers in the United States on using photovoltaic (PV) technology. Third, the BLM is receiving increasing interest (through applications for PV solar energy development on BLM-administered lands) in more northern latitudes beyond the six states subject to the Western Solar Plan.

In response to these changes, the BLM needs to update its administration of the public lands to facilitate responsible siting of solar energy development. The BLM seeks to accomplish this by amending its land use plans in the six states subject to the Western Solar Plan and those in the expanded area of the five additional states to exclude solar energy development applications from areas where protection is warranted based on critical need(s). The land use plan amendments would also involve updating design features and environmental evaluation processes and incorporating new information and additional environmental analysis.

This planning effort will serve the BLM's administration and management of public lands under the principles of multiple use and sustained yield and respond to direction in the Energy Act of 2020, which exhorts the Secretary of the Interior to support national renewable energy goals on public lands including the goal laid out in that Act to "seek to permit at least 25 GW of electricity from wind, solar and geothermal projects by 2025." It is also consistent with and responds to Executive Order (E.O.) 14008, "Tackling the

Climate Crisis at Home and Abroad" (86 FR 7619) issued in February 2021, which states that it is the policy of the United States

> *"to organize and deploy the full capacity of its agencies to combat the climate crisis to implement a Government-wide approach that reduces climate pollution in every sector of the economy; increases resilience to the impacts of climate change; protects public health; conserves our lands, waters, and biodiversity; delivers environmental justice; and spurs well-paying union jobs and economic growth, especially through innovation, commercialization, and deployment of clean energy technologies and infrastructure."*

In addition, this effort addresses E.O. 14057, *Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability* (86 FR 70935), issued in December 2021, which directs the federal government to lead by example to achieve a carbon pollution-free electricity sector by 2035 and net-zero emissions economy-wide no later than 2050.

1.1.2 BLM's Decisions to be Made Under the Land Use Planning Process

FLPMA requires the BLM to develop land use plans, also called RMPs, to guide the management of the lands it administers. An RMP typically covers BLM-administered lands within a particular BLM field office. The BLM's *Land Use Planning Handbook* (BLM 2005a) provides specific guidance for preparing, amending, and revising land use plans.

The BLM periodically reviews and amends its land use plans to reflect changes in the scope and nature of the appropriate use of the public lands. Through these amendments, the BLM may identify land use allocations or designations, including right-of-way (ROW) avoidance areas (which may be available for development) or exclusion areas (which are not available for development). The BLM may also identify areas open for application for renewable energy development (e.g., solar application areas). In addition, the BLM may identify terms and conditions that apply to solar application areas, including BMPs to minimize environmental impacts and limitations on other uses that would be necessary to maintain the ROW values (BLM 2005a). As part of the present effort, land use plans in the 11-state planning area would potentially be amended to address solar energy development (see Appendix A for a list of the proposed plan amendments associated with this Programmatic EIS). The amendments would identify for their respective land use plans the exclusion areas and solar application areas as well as incorporate programmatic design features. Land use plans that are undergoing amendment or revision separate from but concurrent with the development of this Programmatic EIS will be reviewed to identify and resolve inconsistencies between the Programmatic EIS and those separate planning efforts.

On the basis of the analyses presented in this Programmatic EIS and considering the elements described above, the BLM is considering making the following programmatic and land use planning decisions that will update the BLM's Western Solar Plan across an 11-state planning area (excluding the Desert Renewable Energy Conservation Plan [DRECP] area; see Section 1.1.6) to support national renewable energy goals as well as conservation and climate priorities:

1. Land use plan amendments that allocate BLM-administered lands to exclude them from utility-scale solar energy development;
2. Land use plan amendments that allocate BLM-administered lands to make them available for utility-scale solar energy development application;
3. Land use plan amendments to remove variance area land use allocations (see Section 2.4.3);
4. Land use plan amendment to de-allocate the Los Mogotes SEZ in Colorado as a solar energy development priority area (see Section 2.1 for further discussion);
5. Land use plan amendments to update Renewable Energy Development Areas (REDAs) in Arizona to align lands available for or excluded from solar applications with the selected alternative to maintain program consistency of land use allocations across western states; and
6. Land use plan amendments that establish required programmatic design features for utility-scale solar energy development on BLM-administered lands to ensure the most environmentally responsible development and delivery of solar energy.

Chapter 2 provides a detailed discussion of the alternatives being considered. Other policy and guidance may also be issued by the BLM to address procedural elements of the BLM's Solar Energy Program.

The BLM's land use planning regulations at 43 CFR Part 1610, which implement Section 202 of FLPMA, require the BLM to publish and provide for public review the proposed planning criteria that will guide the BLM's land use planning process. Planning criteria are the constraints, standards, and guidelines that determine what the BLM will or will not consider during its planning process. As such, they establish parameters, help focus analysis of the issues identified in scoping, and structure the preparation of the Programmatic EIS. The following planning criteria (which have been refined from the criteria published by the BLM in the NOI based on public comment received on the NOI and further consideration by the BLM) will be used in the development of the Programmatic EIS to assess and analyze RMP amendments:

- The BLM will prepare RMP amendments in compliance with FLPMA, the Endangered Species Act of 1973, as amended (ESA); NEPA; the National Historic Preservation Act; and all other applicable laws, regulations, E.O.s, and BLM policies.
- The BLM will use the Programmatic EIS as the analytical basis for any decision it makes to amend an individual land use plan with respect to that plan's treatment of solar energy development on BLM-administered lands.
- The BLM will develop a reasonably foreseeable development scenario to forecast potential levels of utility-scale solar energy development. It will identify

lands available for utility-scale solar energy application, and lands not available for utility-scale renewable energy development in affected plans.

- The BLM will limit its amendment of these plans to utility-scale solar energy development. The BLM will not directly address the management of other resources, although the BLM will consider and analyze the impacts from increased use on other managed resource values.
- The BLM will continue to manage other resources in the affected planning areas under applicable RMPs and the pre-existing terms and conditions of project-level decisions related to those other resources.
- The BLM will recognize valid existing rights.
- The BLM will coordinate with federal, state, and local agencies in the Programmatic EIS and plan amendment process to strive for consistency with existing plans and policies, to the maximum extent consistent with the purposes of FLPMA and other Federal laws and regulations. [2]
- The BLM will consult with Tribal governments and provide strategies for the protection of recognized traditional uses in the Programmatic EIS and plan amendment process.
- The BLM will take into account appropriate protection and management of cultural and historic resources in the Programmatic EIS and plan amendment process and will engage in all required consultation.
- The BLM will analyze EJ in the Programmatic EIS and plan amendments, recognize the special importance of the BLM-administered lands to local communities, and consider relevant national strategic objectives for renewable energy.
- The BLM will make every effort to provide ample opportunities for public engagement and participation throughout the Programmatic EIS process.
- Environmental protection and energy production are both desirable and necessary objectives of sound land management practices and are not to be considered mutually exclusive priorities.
- The BLM will consider and analyze relevant climate change impacts in its land use plans and associated NEPA documents, including the anticipated environmental and climate change benefits of solar energy development on BLM-administered lands.
- The BLM will use geospatial data in a geographic information system (GIS) to facilitate discussions of the affected environment, formulation of alternatives, analysis of environmental consequences, and display of results.

Scoping comments received encouraged the BLM to follow all the planning criteria, especially coordination and consultation with agencies and Tribes, conducting a thorough EJ analyses, and creating a robust public engagement process.

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[2] See Section 1.1.6 for discussion of consistency with local plans.

1.1.3 Authorization Process for Solar Energy Development on BLM-Administered Lands

The BLM issues ROW grants and leases for solar energy development applications on BLM-administered lands in accordance with Title V of FLPMA, and processes those applications pursuant to FLPMA's ROW implementing regulations at 43 CFR Part 2800 (see Section 3.3.2.1 for a detailed description of the process for issuing solar energy development ROWs). On December 16, 2016, the BLM amended its regulations for issuing solar and wind energy development ROWs (81 FR 92122). These regulations apply to all ROW applications, including in the five new states within the planning area for this Programmatic EIS. Applications in the six states covered by the Western Solar Plan also must comply with the requirements of the 2012 Western Solar Plan ROD (BLM 2012a). The 2016 regulations provide a competitive leasing process for projects in designated leasing areas (DLAs).[3] The regulations also address the non-competitive permitting process for issuing solar energy ROW grants on other BLM-administered lands. Additionally, the 2016 rule streamlines review processes and provides financial incentives designed to encourage development within DLAs. In 2023 the BLM published a proposed rule to update the 2016 regulation framework for solar and wind energy projects on public lands.[4]

When the BLM considers the potential authorization for the construction of utility-scale solar energy generation facilities on BLM-administered lands, it must comply with applicable law, including NEPA, the ESA, and the National Historic Preservation Act. The BLM's project-specific analysis must address all applicable components of the solar energy generation facility during all phases of project planning, construction, operation, and decommissioning. In addition, solar energy development must be in conformance with the existing, approved land use plan.

As of December 2022, the BLM had permitted 41 solar energy projects, totaling 9,273 megawatts (MW), on approximately 73,000 acres of BLM-administered lands (Table 1-1).

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[3] DLAs were defined as "priority areas" and include SEZs, Renewable Energy Development Areas designated for solar energy development under the Arizona Restoration Design Energy Project (BLM 2013a) and solar emphasis areas in Colorado (BLM 2015).

[4] In June 2023, the BLM issued a proposed rule, *Rights-of-Way, Leasing, and Operations for Renewable Energy* (81 FR 92122). Among other things, the rule would reduce acreage rents and capacity fees for solar energy development, expand the BLM's ability to accept lease applications in DLAs, and expand the BLM's ability to accept non-competitive leasing applications when in the public interest.

Table 1-1. Solar Energy Projects on BLM-Administered Lands

State	No. and Capacity of Operational Solar Energy Facilities	No. and Capacity of Solar Energy Facilities Pending Construction	Area of Operational and Planned Facilities (acres)
Arizona	4 (0.66 MW)	3 (725 MW)	9,035
California	11 (2,987 MW)	8 (2,817)	40,766
Nevada	6 (659 MW)	5 (1,401 MW)	17,697
New Mexico	1 (2 MW)	1 (1 MW)	14
Utah	None	1 (600 MW)	4,836
Wyoming	1 (80 MW)	None	584
TOTAL	**23 (3,729 MW)**	**18 (5,544 MW)**	**72,932**

1.1.4 BLM's Scope of Analysis

The BLM's *Land Use Planning Handbook* (BLM 2005a) defines a *planning area* as the geographic area within which the BLM will make decisions during a planning effort. A planning-area boundary includes all lands regardless of jurisdiction; however, the BLM's decisions necessarily apply only to those lands that fall under the BLM's jurisdiction. Because of increased interest in solar energy development on BLM-administered lands outside of the six-state area addressed under the Western Solar Plan and to provide planning consistency across the 11 Western states, the BLM has determined that the planning area, or geographic scope, of this Programmatic EIS will include an 11-state planning area (i.e., Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming) (see Figure 1-1). The *decision area* (lands for which the BLM has authority to make land use and management decisions) includes all BLM-administered lands in these 11 states, except for lands covered by the decision area of the DRECP Amendment to the California Desert Conservation Area (CDCA) Plan, Bishop RMP, and Bakersfield RMP.

As described in the 2022 NOI for this Programmatic EIS, the BLM considered the extent to which lands covered by the DRECP, an interagency landscape-scale planning effort covering 22.5 million acres of public and private land in seven southern California counties, with a BLM decision on 11 million of those acres, should be included in the planning area for this Solar Programmatic EIS. Many comments received during the public scoping process urged the BLM to exclude lands within the DRECP decision area from the planning area. After consideration, the BLM chose not to consider the area subject to the DRECP in this Programmatic EIS, as the BLM continues to believe the DRECP supports an acceptable integration of conservation and renewable energy opportunities within its decision area boundary. Public comments received during the scoping period support this approach. The BLM has removed the DRECP decision area from the planning area for this Programmatic EIS and will not amend the DRECP as a part of this process.

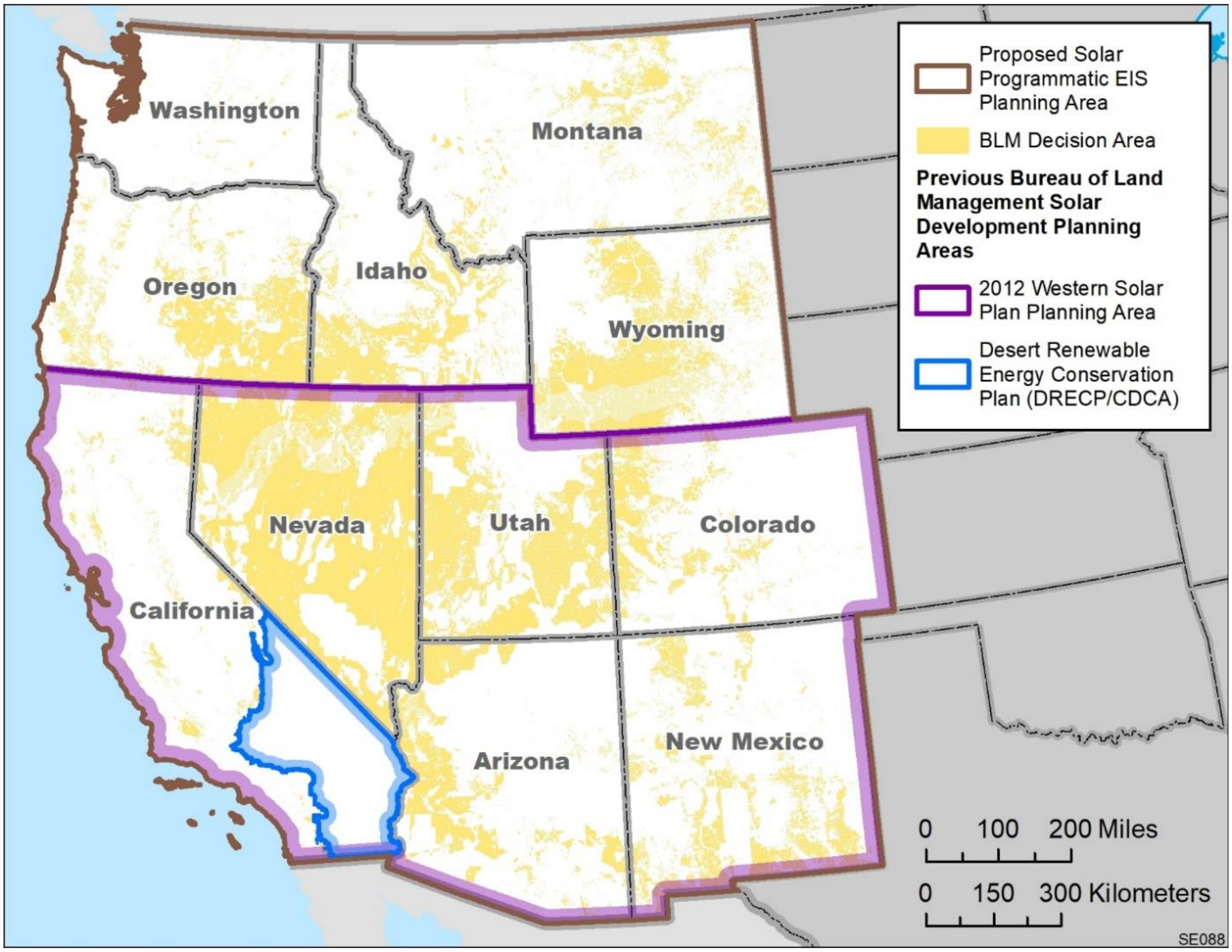


Figure 1-1. Geographic Scope of the Programmatic EIS 11-State Planning Area.

The BLM has decided that this Programmatic EIS will focus on PV solar energy facilities, which encompass the majority of solar energy facility applications received by the BLM to date. The concentrating solar technologies (including parabolic trough, power tower, and dish engine) that were evaluated in the Western Solar Plan are no longer widely prevalent technologies. Because this Programmatic EIS does not evaluate the impacts of concentrating solar power (CSP) facilities on BLM-administered lands, should any applications for CSP facilities be received, they will be processed on a project-specific basis, consistent with existing land use plan allocations and decisions. It may be appropriate to apply many of the design features applicable for PV developments to future CSP projects. The BLM also considered whether the definition of utility-scale solar energy development should be modified. The Western Solar Plan decisions apply to utility-scale solar energy development, which is defined as any solar project capable of generating 20 MW or more of electricity that is delivered to the electricity transmission grid. Any proposed project with a generation capacity of less than 20 MW, therefore, is not covered under the Western Solar Plan, and decisions on such projects are based on existing land use plan requirements, applicable policy, and site-specific NEPA analyses. With further research and considering public comments received during the public scoping period, the BLM has chosen to define any solar projects with nameplate (the theoretical output registered with authorities) capacity of

5 MW or higher as utility-scale. Setting the definition at 5 MW or higher is consistent with the definition of utility-scale used by Lawrence Berkeley National Laboratory and the National Renewable Energy Laboratory for reporting on such development in the United States and projecting solar energy development in the future, respectively (Bolinger et al. 2022; Denholm et al. 2022). All Action Alternatives in this Programmatic EIS consider projects of 5 MW or higher to be utility-scale solar energy development projects.

The Western Solar Plan excludes solar energy development where solar insolation values are below 6.5 kWh/m^2. Owing to technological advances and reduced costs in PV systems, the BLM receives continued interest from PV solar energy developers in locations that were allocated as exclusion areas under the Western Solar Plan on the basis of low solar insolation values. In addition, many comments received during the public scoping process supported elimination of the solar insolation exclusion. The BLM agrees that areas with solar insolation below 6.5 kWh/m^2 may be viable for solar energy generation, and these areas are not excluded under the Action Alternatives in this Programmatic EIS. The slope exclusion criterion that is also included in the Western Solar Plan to exclude lands with greater than 5% slope has been modified to greater than 10% in some of the alternatives being evaluated (see Section 2.2.1.1).

The scope of this impact analysis includes an assessment of the environmental, cultural, and economic impacts of PV utility-scale solar energy developments, as well as the impacts of supporting facilities and transmission connections from these facilities to the existing electricity transmission grid. Although the Solar Programmatic EIS considers the impacts of constructing, operating, maintaining, and decommissioning the supporting facilities and transmission connections such as roads, transmission lines, and natural gas or water pipelines, the land use plan decisions to be made (e.g., exclusions, solar application areas) will apply only to utility-scale solar energy developments (i.e., solar energy generation facilities). Management decisions for supporting infrastructure would continue to be made in accordance with existing land use plans and applicable policy. Solar energy developments would be further analyzed in project-specific environmental reviews in accordance with NEPA, including analysis of both the energy development and supporting infrastructure, as appropriate.

During the BLM’s scoping process, the BLM also solicited feedback on the following concepts related to renewable energy development. Both were excluded from the scope of analysis in this Programmatic EIS, as described below:

- *Incentivizing utility-scale solar energy development.* In the NOI, the BLM asked for public comment on ways that it might incentivize development in priority or preferred areas. Public comment did not identify means of incentivization that could be implemented through the land use planning process. Most suggestions about incentivization would require changes to BLM regulations.
- *Wind energy planning needs on BLM-administered lands.* The BLM requested feedback about the potential need for wind energy development planning across BLM-administered lands in western states during the scoping process for this Programmatic EIS. The BLM did receive a variety of feedback during the scoping

process, but it will contemplate comprehensive wind energy development planning outside of this Programmatic EIS process.

1.1.5 BLM's Requirements for Further Environmental Analysis

This Programmatic EIS will not alleviate the need for project-specific analyses for solar energy development at the local level. Rather, the programmatic-level identification of the lands available and unavailable for solar energy development under this Programmatic EIS is an important step to guide solar developers to locations that the BLM anticipates having fewer issues with critical resources or other critical uses. This increases management consistency and avoids cost and time associated with evaluating proposed projects in unsuitable areas.

The Action Alternatives described in Chapter 2 identify types of BLM-administered lands that are generally unsuitable for solar energy development as exclusion areas. These exclusion areas include lands that are currently managed for other priorities based on current needs and available resource information for which the BLM has nationally approved datasets. Public lands not excluded based on comprehensive data may be available to solar application submissions, depending on the alternative. However, identifying lands as available for application does not mean that such lands have affirmatively been determined by the BLM to be suitable for solar energy development.

When the BLM receives a right-of-way application for a solar energy development on available public lands, the agency will undertake a detailed project-specific environmental review in accordance with applicable laws and regulations. The project-specific evaluation will include a comprehensive review and analysis to determine the potential site-specific impacts to resources and other uses to determine the suitability for the proposed solar energy development. The BLM may tier to relevant analysis in this Programmatic EIS but will consider site-specific impacts of individual project applications prior to any agency decision.

Applications for solar energy projects on BLM-administered lands must comply with regulations at 43 CFR Part 2800, under which the BLM may require submission of a project plan of development that addresses all known or potential conflicts with sensitive resources and values and includes proposed measures to avoid, minimize, and/or compensate for such resource conflicts. Furthermore, applications will be reviewed to (1) identify and change or eliminate any aspects of the project not in conformance with the applicable land use plan; (2) apply stipulations (in addition to the design features developed in this EIS) to address local conditions (for example, modifying a project area to avoid habitat or cultural resources); and (3) consider feedback and concerns from local community members and project modifications to address those concerns. Appropriate project siting configurations must be determined with local input and the BLM may consider implementing design features that may buffer or avoid resources even within areas identified in this Programmatic EIS as available for application. The project review process may result in the modification, rejection, or denial of the application as determined appropriate by the BLM. Project-specific reviews will include focused evaluation of the area proposed for application, including a detailed consistency review with the applicable land use plan and consideration of resource-related conflicts, public concerns, and proximity to important resources. Decisions to approve a solar application must comply with NEPA.

This project- and location-specific analysis is essential to incorporate data not available or not consistent across the 11-state study area. For example, for some resources, such as big-game migration corridors, while available non-BLM datasets identify very large areas of potential big-game use in addition to the excluded area, project-specific analysis may show that solar energy development is either compatible or incompatible with the resource use.

Understanding and taking into account the diverse values of public lands and existing resources and other uses is crucial to informing the BLM's land management decisions. The BLM's mission of multiple-use and sustained yield is best achieved by conducting environmental reviews and analyses that are appropriately scaled. This means considering the various environmental factors in specific situations at the right time and in the right context.

1.1.6 Consistency with Local Land Use Plans

FLPMA, Title II, Section 202, directs the BLM to coordinate planning efforts with Native American Indian Tribes, other federal departments, and agencies of state and local governments. To accomplish this, the BLM is directed to keep apprised of state, local, and Tribal plans; assure that consideration is given to such plans; and assist in resolving inconsistencies between such plans and federal planning. The section goes on to state in Subsection I(9), "Land use plans of the Secretary [of the Interior] under this section shall be consistent with state and local plans to the maximum extent he finds consistent with federal law and the purposes of this Act" (43 U.S.C. § 1712I(9)).

The BLM's FLPMA resource management planning regulations (43 CFR 1610.3-2) provide additional details, requiring that BLM RMPs be consistent with officially approved or adopted resource-related plans of other Federal, State, local, and Tribal governments, to the extent that those plans are also consistent with the purposes, policies and programs of Federal laws and regulations applicable to public lands. In the event of inconsistency or potential inconsistency, the BLM follows the procedures set forth in the regulations (43 CFR 1610.3-2).

In keeping with the provisions of these sections, the BLM established regular opportunities for interaction with state and local officials. State and local officials have reviewed and provided input on the alternatives as cooperating agencies. From these interactions, the BLM understands that some counties would prefer to limit solar energy development to disturbed lands where conflicts with resources and other land uses would be minimized. Some state and local cooperating agencies also expressed interest in excluding lands which have wilderness characteristics and adding buffers between solar energy development and certain resources or areas (such as private property or town boundaries). Several states and counties within the 11-state planning area also have resource and land use policies and plans that restrict land available for utility-scale solar energy development. The BLM will continue to consider consistency of the alternatives with state and local plans in developing the proposed RMPA and Final EIS.

Under Section 1610.4-7 of the BLM resource management planning regulations, this Draft Programmatic EIS is provided to the Governor, other federal agencies, state and local governments, and Native American Tribes for comment. Through this process, additional input will be provided on how the local plans may or may not be consistent with the alternatives. The resulting comments will be addressed in the Proposed RMPA/Final EIS. A formal 60-day consistency review by each Governor of the 11 states within the planning area follows publication of the Proposed RMPA/Final EIS, as outlined in 1610.3-2I of the BLM planning regulations. Information from all these efforts will help inform the BLM's ultimate Record of Decision.

1.2 Outreach and Engagement

The BLM's outreach efforts included publication of the NOI, distribution of news releases, public scoping meetings (both in-person and virtual), and informational letters to Tribes. The NOI to prepare this Programmatic EIS was published in the *Federal Register* (87 FR 75284) and on the BLM's *National NEPA Register* on December 8, 2022. The BLM also sent informational letters to 241 federally recognized Tribes with affiliated lands within the 11-state planning area on December 5, 2022 (see Appendix D for details). These actions initiated the scoping process for the Programmatic EIS.

The BLM hosted 15 public scoping meetings: 3 virtual and 12 in person (details provided in Section 6.1). The purpose of these meetings was to inform the public about the project and to provide an opportunity for individuals to submit oral comments. Of the 297 unique written submissions and 75 oral comments heard at the scoping meetings, the BLM identified 2,026 unique comments. All scoping comment submittals were reviewed and categorized by individual topics addressed. Table 1-2 identifies the comment categories and percentage of comments in each category. In addition to unique submissions, more than 20,000 campaign letters sponsored by conservation and other organizations were received (see Section 6.1).

The scoping summary report and copies of comments were made available to the public during May 2023 through the *National NEPA Register* (BLM 2023d).

Table 1-2. Scoping Comment Categories and Number of Comments in Each Category

Comment Category	Number of Comments (total = 2,026)	% of Comments	Report Section
NOI/Scoping	**840**	**42**	**2.1**
Expand or limit the planning area	26	1.3	2.1.1
DRECP concerns	95	4.7	2.1.1.1
Add new states	61	3.0	2.1.1.2
Land use allocations	91	4.5	2.1.2
Locate near transmission	67	3.3	2.1.2.1
Develop on disturbed lands	87	4.3	2.1.2.2
Exclusion criteria	14	0.7	2.1.3
Technology-based exclusions	55	2.7	2.1.3.1
Resource-based exclusions	137	6.8	2.1.3.2
Exclusion buffers around populated areas/Specially Designated Areas	53	2.6	2.1.3.3
Variance process	76	3.8	2.1.4
Change the definition of utility scale	45	2.2	2.1.5
Incentivize development in priority areas	59	2.9	2.1.6
NEPA Process	**467**	**23**	**2.2**
NEPA process: general	**73**	3.6	2.2
Public outreach	45	2.2	2.2.1
Comment period extension request	52	2.6	2.2.2
Consultation	32	1.6	2.2.3
Best available information and baseline data	85	4.2	2.2.4
GIS data and analysis	21	1.0	2.2.5
Cumulative impacts	30	1.5	2.2.6
Coordination	53	2.6	2.2.7
Cooperating agencies	18	0.9	2.2.8
Mitigation	50	2.5	2.2.9
Monitoring	8	0.4	2.2.10
Federal Law	**5**	**0.25**	**2.3**
Federal law: general	**5**	0.2	2.3
Resource Concerns	**442**	**22**	**2.4**
Air quality	11	0.5	2.4.1
Climate change	19	0.9	2.4.2
Cultural resources and Tribal concerns	27	1.3	2.4.3
Disturbed lands: wildfire, invasive species	20	1.0	2.4.4
Ecological resources: vegetation, wildlife, special status species	110	5.4	2.4.5
Geology	14	0.7	2.4.6
Human health	33	1.6	2.4.7
Land use: livestock grazing, mining, recreation, special designations, and wild horses and burros	75	3.7	2.4.8
Socioeconomics and EJ	65	3.2	2.4.10
Visual resources	15	0.7	2.4.11
Water resources	53	2.6	2.4.12
Planning Issues	**272**	**13**	**2.5**
Issues to be carried forward in the Programmatic EIS	81	4.0	2.5.1
Include wind in this Programmatic EIS effort?	72	3.6	2.5.2
Did it work? (referring to the Western Solar Plan)	15	0.7	2.5.3
Issues out of scope	104	5.1	2.5.4

1.3 Relationship to Other Programs, Policies, and Plans

There are many ongoing and recently completed BLM efforts that address environmentally responsible development and management of BLM-administered lands in the western United States. Some examples of such initiatives that are related to solar energy development are discussed below. These demonstrate some of the challenges the BLM faces in managing public lands under the principles of multiple use, including renewable energy and transmission, and underscore the importance of communication and transparency among agencies and stakeholders.

1.3.1 Energy Corridor Designation

In accordance with Section 368 of the Energy Policy Act of 2005, the BLM and U.S. Forest Service (USFS) amended their respective land use plans and designated energy corridors on federal lands in the 11 western states that are within the scope of the current solar planning effort (DOE et al. 2008). Section 368 energy corridors are lands designated as preferred areas for energy transport infrastructure (e.g., electric transmission lines, natural gas pipelines).

The designation of energy corridors may affect energy development throughout the western United States, including utility-scale solar energy development, because the siting of energy corridors will facilitate development by removing key restraints on construction of new electric transmission lines on federally managed lands. The presence of sufficient transmission infrastructure is a consideration of all solar energy projects.

1.3.2 California DRECP

In 2016, the BLM’s California State Office signed a ROD for the 11 million-acre DRECP that amended land use plans in the Mojave and Colorado/Sonoran Deserts of southern California (BLM 2016a). To help streamline and incentivize utility-scale renewable energy generation, the DRECP ROD designated Development Focus Areas as areas with substation energy generation potential, access to existing or planned transmission, and low resource conflicts. The DRECP also designated Variance Process Lands, areas where renewable energy development may be considered and could be approved without a plan amendment, and General Public Lands where renewable energy development may be considered but a plan amendment would be required for project approval. Last, certain protected lands were excluded from future renewable energy development. At the end of the public scoping period for this Solar Programmatic EIS, the BLM announced that the DRECP decision area (southern California) will not be included in the planning area for the Programmatic EIS (see also Section 1.1.6). The DRECP Amendment to the CDCA Plan, Bishop RMP, and Bakersfield RMP, will continue to provide management direction on these 11 million acres of BLM-administered lands.

1.3.3 Arizona Restoration Design Energy Project (RDEP)

The BLM Arizona State Office amended land use plans and signed a ROD in 2013 for the RDEP, which designated Renewable Energy Development Areas (REDAs) on public lands (BLM 2013a). REDAs are areas where solar and wind energy development is likely to be compatible with resource objectives. The RDEP built upon the analysis in the Western Solar Plan (for example, all public-land REDAs were in variance areas), and designated a new SEZ (Agua Caliente SEZ), where utility-scale solar energy development could be approved without a plan amendment. REDAs identified for solar energy development are also considered to be DLAs (see Section 1.1.4). Through this Programmatic EIS planning effort, the BLM is considering elimination of the REDA designations in Arizona (see Section 2.1).

1.3.4 Sage-Grouse Planning

1.3.4.1 Greater Sage-Grouse Planning

In 2015, the U.S. Fish and Wildlife Service (USFWS) found that listing the greater sage-grouse under the ESA was not warranted because the primary threats to the species had been ameliorated with conservation efforts on federal, state, and private lands. The USFWS's determination relied heavily on land use plans amended by the BLM and USFS in 2015 which focused on conserving, enhancing, and restoring sagebrush ecosystems across the western United States.

These plans designated habitat management areas, one of which was sagebrush focal areas (SFAs), which is a subset of Priority Habitat Management Areas (PHMA) and represents the most important sage-grouse habitat. Almost all anthropogenic disturbance is prohibited or heavily restricted within SFAs.

In 2019, the BLM amended these land use plans again, focusing on better aligning with State sage-grouse habitat management plans. On October 16, 2019, the U.S. District Court for the District of Idaho temporarily enjoined these plans, so the 2015 plans remain in effect. The BLM is currently conducting another land use planning process to address the continued decline of sage-grouse habitat.

As part of the planning process, the BLM is examining new scientific information, including the effects of stressors like climate change, to assess what management actions may best support sagebrush habitat conservation and restoration on BLM-administered lands to benefit sage-grouse, as well as the people who rely on this landscape to support their livelihoods and traditions.). This planning process will amend BLM land use plans on over 67 million acres of greater sage-grouse habitat.

1.3.4.2 Bi-State Distinct Population Segment of Greater Sage-Grouse

The Bi-State sage-grouse is subpopulation of the greater sage-grouse that occupies habitat on the California and Nevada border along Eastern Sierra and Western Great Basin. The Bi-State population is recognized by the USFWS as a Distinct Population

Segment (DPS), and like the greater sage-grouse, it has a long history of consideration for listing under the ESA. On May 16, 2022, the U.S. District Court for the Northern District of California vacated and remanded previous Bi-State sage grouse decisions that withdrew listing proposals by the USFWS and reinstated the proposal to list the species as threatened. The Court also vacated and remanded previous USFWS decisions to withdraw the critical habitat proposals and reinstated critical habitat as proposed. Currently Bi-State sage grouse is proposed as threatened with a proposed 4(d) rule (88 FR 25613, April 27, 2023) and critical habitat is proposed (78 FR 64358 and 64328, October 28, 2013; 88 FR 25613, April 27, 2023) Conservation of the Bi-State DPS is led by the Bi-State Local Area Working Group and has a long tradition of support by committed state, federal, and local partners to conserve key seasonal habitats and migration corridors. The USFWS is planning to make a listing decision by May 2024.

1.3.4.3 Gunnison Sage-Grouse Planning

In 2016, the BLM released a Gunnison Sage-Grouse Draft RMP Amendment and EIS, (BLM 2016o), but canceled the planning effort following an announcement that the USFWS intended to complete a recovery plan for the species. The USFWS released the Final Recovery Plan for the species in 2020 (USFWS 2020), prompting the BLM to reengage in this effort. The BLM is preparing an EIS to determine whether to amend the land use plans of BLM field offices, national monuments, and national conservation areas containing occupied and unoccupied habitat for the threatened Gunnison sage-grouse (BLM 2023f).

1.3.5 Changes to Solar Energy Development Land Use Designations in Colorado since 2012

The Fourmile East SEZ, located on the east side of the San Luis Valley, Colorado, was established by the Western Solar Plan through an amendment to the San Luis Resource Area (SLRA) RMP. The SEZ totaled 6,412 acres. The original allocation of the SEZ included a withdrawal of the zone from mineral entry. Consultation with Native American Tribes subsequent to issuance of the Western Solar Plan determined that development of the SEZ would have high potential to cause significant impacts on Native American cultural and religious values that exist for this area near Mount Blanca and the surrounding viewshed. Additional concerns regarding potential solar development in this SEZ included the presence of vital wildlife migration routes and dark night sky values in proximity to the Great Sand Dunes National Park and Preserve. In response to these consultation findings, the BLM amended the SLRA RMP in 2018 and deallocated the Fourmile East SEZ.

Through this Programmatic EIS planning effort, the BLM is proposing to de-allocate the Los Mogotes SEZ (also in the San Luis Valley); that is, the lands within the SEZ would no longer be available for utility-scale solar energy development (see Section 2.1.1).

In 2015, the *Grand Junction Field Office Record of Decision and Approved RMP* (BLM 2015a) was released. This planning effort identified approximately 12,000 acres within the field office area as solar emphasis areas. These solar emphasis areas are well suited for utility-scale solar energy development and are considered to be DLAs (see Section 1.1.4).

1.3.6 Changes to Solar Energy Development Land Use Designations in Nevada since 2012

In 2019, the BLM Nevada State Office designated a new 1,800 acre solar DLA (Dry Lake East) (BLM 2019a). A parcel including most of this land was auctioned in 2022, and a solar project is now under construction in the DLA.

1.3.7 Landscape-Level Planning Efforts

BLM incorporates landscape-level planning to inform the management and maintenance of public land health. In addition to the BLM's current Western Solar Plan, other BLM landscape-level efforts include the greater sage-grouse planning effort (see Section 1.3.4) and rangeland health assessments (Pellant et al. 2020). In April 2023, the BLM also published proposed regulations to manage public lands by prioritizing the health and resilience of ecosystems at a landscape level (88 CFR Part 19583). These landscape-level planning efforts often involve collaboration with public and private partners and stakeholders. In these assessments, the BLM considers landscape-level data provided by stakeholders and partners on the status and trends of natural resources to make informed, science-based decisions on landscape health and sustainability.

2 Description of Alternatives and Reasonably Foreseeable Development Scenario

This Programmatic EIS examines alternative management approaches the BLM could implement for utility-scale[1] solar energy development on BLM-administered land. This chapter describes each of those alternatives. The land use allocations and design features presented under each Action Alternative would be applicable to all utility-scale photovoltaic (PV) solar energy projects on BLM-administered lands in the 11-state planning area (i.e., projects implemented under a BLM-issued right-of-way [ROW] authorization). PV is the technology most likely to be deployed over the next 20 years (see Section 1.1.6).

Section 2.1 describes the alternatives in detail, including exclusion criteria and design features. Section 2.2 presents the results of a Reasonably Foreseeable Development Scenario (RFDS) analysis for solar energy over the next 20 years. Section 2.3 discusses other alternatives and issues considered but eliminated from detailed analysis in this Programmatic EIS. Section 2.4 provides a summary comparison of the alternatives. Section 2.5 identifies the BLM's preferred alternative.

2.1 BLM's Alternatives

This Programmatic EIS examines five Action Alternatives, each of which would involve the identification of BLM-administered lands available for or excluded from utility-scale solar applications in the 11-state planning area, as well as presenting updated programmatic design features for solar development. This Programmatic EIS also examines a No Action Alternative that would continue the BLM's existing management of utility-scale solar energy development under approved land use plans, including the 2012 Western Solar Plan, as further amended since 2012, and under the BLM's existing regulations for solar energy development.[2]

The BLM may choose to adopt one of the alternatives or a combInation of alternatives; selected alternatives could also vary by geographic region. Combining alternatives could involve applying the concept of one of the more restrictive alternatives while changing the scope of the restriction to include lands available under one of the less restrictive alternatives. For example, Alternatives 3 and 5 would limit development to within 10 miles of transmission lines. Changing the scope of the restriction to include lands at some greater distance from transmission lines would effectively be combining Alternative 3 or 5 with Alternative 1 or 2, which both extend to those lands a greater distance from transmission (and beyond). Similarly, the BLM may also choose to exempt some or all existing ("pending") applications from the management actions and

[1] Utility-scale solar energy development is defined as projects of 5 MW nameplate capacity or higher.

[2] Amendments to the 2012 Western Solar Plan include addition of the Agua Caliente SEZ in Arizona, the West Chocolate Mountain SEZ in California, the Dry Lake East DLA in Nevada, REDAs in Arizona, and solar emphasis areas in Colorado; and deletion of the Fourmile East SEZ in Colorado, as detailed in Section 1.3.

allocations in plan amendments supported by this Programmatic EIS by applying portions of the No Action Alternative to those pending applications.[3]

2.1.1 Action Alternatives

Each of the five Action Alternatives would amend resource management plans to identify BLM-administered lands available for or excluded from application for utility-scale solar energy development in the 11-state planning area (see Appendix A for a list of the proposed plan amendments associated with this Programmatic EIS). Under all Action Alternatives, a proposed ROW would only be approved following an appropriate project-specific review, and a decision to issue a ROW would need to comply with NEPA (see Section 1.1.5).[4] Any utility-scale solar application that includes areas located *within an exclusion area* would require a land use plan revision or amendment prior to approval. The proposed plan amendments associated with this Programmatic EIS would also update programmatic design features and the land use allocations for variance lands and the variance process under the Western Solar Plan would be removed and eliminated, respectively.

The reasonable range of Action Alternatives are incorporate scoping comments, cooperating agency input, and the BLM's experience and expertise in managing public lands for multiple uses and sustained yield to make varying amounts of lands available for solar applications. Exclusion criteria identify areas not available for solar applications. Alternative 1 opens the most lands to solar applications. Alternatives 2 through 5 open progressively less land to solar applications. As discussed further below, resource-based exclusion criteria apply across all alternatives and a general resource-based exclusion for areas with slopes 10% or greater applies to Alternatives 2 through 5.

Many exclusion criteria were applied under the Western Solar Plan. The BLM's use of exclusion criteria again in this planning effort to prohibit solar energy development in sensitive areas would mitigate potential environmental impacts from solar energy development by avoiding impacts to sensitive areas altogether. Programmatic design features required under all the Action Alternatives would provide additional mitigation by minimizing impacts from proposed solar development. Details on Exclusion Criteria and Design Features are provided in sections 2.1.1.6 and 2.1.1.7, and Appendix B.

All Action Alternatives would eliminate the Western Solar Plan's variance process and remove the land use allocations for variance lands. However, under all Action Alternatives, the BLM would perform a similar screening analysis when processing solar applications, in accordance with existing regulations, policy, and procedures (see 43 CFR Part 2800). Specifically, the BLM would individually evaluate each application and apply screening criteria to identify potential intersections with areas of special

[3] The BLM expects to consider a variety of factors in determining whether pending projects will be subject to the management actions and allocations in plan amendments supported by this Programmatic EIS.

[4] A project includes the PV solar energy facility, supporting facilities, and transmission connections, and may be permitted under one or several ROWs.

concern prior to initiating NEPA analysis. The areas of special concern were identified during preparation of this Programmatic EIS based on input from the National Park Service (NPS), U.S. Fish and Wildlife Service (USFWS), cooperating agencies, and BLM subject matter experts (areas of special concern are presented in Appendix H). In cases where screening identifies an intersection between a proposed project and areas of special concern, project developers could propose avoidance and/or other mitigation measures to address resource concerns. The screening process would preserve some aspects of the Western Solar Plan's variance process but would eliminate redundancy with application processing elements under BLM regulation or policy.

The BLM considered additional deviations from the Western Solar Plan in developing the reasonable range of alternatives, including eliminating the slope criterion (the 2012 Western Solar Plan excluded all lands >5% slope), because both the solar technologies employed and the technological limitations of those technologies change over time (for example, engineering advances may allow construction in somewhat higher sloped areas without resulting in substantial soil erosion). Because these changes can occur over the BLM's land use planning timeframe, the BLM determined that it would be infeasible to update a slope exclusion criterion in response to technological developments over time. However, the BLM received extensive comments during the scoping process for the Programmatic EIS supporting the retention of a slope exclusion criterion because applying that exclusion generally prevents unnecessary and undue degradation to the public lands and has the incidental benefit of helping further to avoid resource impacts (BLM 2023d). For example, the U.S. Environmental Protection Agency (EPA) and U.S. Fish and Wildlife Service (USFWS) expressed concerns about development in higher slope areas due to the potential for increased erosion and impacts on surface hydrology, wildlife, and visual resources. Some nongovernmental organizations noted that areas with higher slopes are often associated with ridges and other linear topography, and therefore facilitate wildlife movement and support regional habitat connectivity. Overall, resources potentially impacted by solar energy development on higher-sloped lands include cultural, ecological, soil, Tribal, and visual resources. In light of these concerns, the BLM proposes to retain a slope exclusion criterion for all alternatives except Alternative 1. However, consistent with many comments, the BLM proposes to set that limitation at 10% (instead of the 5% applied under the 2012 Western Solar Plan).

The existing priority areas would be carried forward as-is for utility-scale solar ROW application, except for Los Mogotes SEZ in Colorado and the REDAs in Arizona. Under each of the Action Alternatives, the BLM is proposing to de-allocate and exclude the Los Mogotes SEZ (also in the San Luis Valley); that is, the lands within the SEZ would no longer be available for utility-scale solar energy application. (Note that, similar to the deallocation of the Fourmile East SEZ, this action is proposed as a result of a determination through further consultation with Native American Tribes that solar energy development within the SEZ area would have high potential to cause significant impacts on Native American cultural and religious values.) The public land areas which comprise the REDAs in Arizona would no longer be allocated as DLAs but some amount of the land within the current REDAs may remain available for application, with the extent of what is available differing by each Action Alternative.

Table 2.1-1 provides a summary description of the five Action Alternatives. Table 2.1-2 summarizes the BLM-administered lands available for application by state and in total for the No Action Alternative and each of the Action Alternatives.[5] Alternative descriptions and maps showing areas available for application and excluded areas are provided in the following subsections. Note that the solar application areas given for each alternative in Table 2.1-2 are *estimates* of the actual areas available for application, because some types of exclusions could not be mapped (see Table 2.1-3).

2.1.1.1 Alternative 1: Resource-Based Exclusion Criteria Only

Under Alternative 1, the BLM would identify BLM-administered lands in the 11-state planning area as either available for or excluded from application. The basis for excluding lands would be to protect known areas of importance for many different cultural, environmental, or other resources from the impacts of solar energy development. The specific categories of lands that would be excluded from solar energy application (i.e., the resource-based exclusion criteria) are listed in Table 2.1-3.

The remaining BLM-administered lands in the planning area would be available for utility-scale solar ROW application under the conditions specified in the ROD for this Solar Programmatic EIS (for example, implementation of design features would be required).

[5] To simplify the GIS analysis of alternatives and because utility-scale solar is unlikely in such areas, isolated parcels of BLM-administered land smaller than 20 acres were not included in the areas calculated for each of the alternatives.

Table 2.1-1. Summary Description of the Action Alternatives for the 11-State Planning Area[a]

Action Alternative	Alternative 1 (Resource-Based Exclusions Only)	Alternative 2 (Resource-Based Exclusions and >10% Slope)	Alternative 3 (Transmission Proximity)	Alternative 4 (Previously Disturbed Lands)	Alternative 5 (Previously Disturbed Lands and Transmission Proximity)
What lands are available for application for solar energy development?	Solar application areas are all lands in 11-state planning area except for the excluded areas described below.	Solar application areas are lands in 11-state planning area except for the excluded areas described below.	Solar application areas are lands within 10 miles of existing and/or planned transmission lines $\geq$100 kV except for the excluded areas described below.	Solar application areas are previously disturbed lands (which have diminished resource integrity) except for the excluded areas described below.	Solar application areas are previously disturbed lands (which have diminished integrity) within 10 miles of existing and/or planned transmission lines $\geq$100 kV except for the excluded areas described below.
What lands are excluded from solar energy development?	No slope-based exclusion	**10% Slope Exclusion** applies to Alternatives 2-5 as a general resource protection measure.			
	Resource-Based Exclusion Criteria (Table 2.1-3) are applied to all Action Alternatives. For example, exclusion criteria would prohibit solar energy development in all designated and proposed critical habitat areas for species protected under the ESA or in BLM National Conservation Lands.				
What about remaining lands that are not solar application areas or excluded under resource-based exclusion criteria or the slope restriction?	Not applicable (no remaining lands)	Not applicable (no remaining lands)	No development outside of these areas. Remaining areas are excluded.		
Do design features apply to the solar application areas?	**Design Features are applied to all Action Alternatives**. Design features are project requirements incorporated into the alternatives to avoid, minimize, and/or compensate for adverse impacts. For example, an ecological design feature could require turning off all unnecessary lighting at night to limit attracting wildlife, particularly migratory birds.				

[a] Consists of Arizona, California (excluding the DRECP area), Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

Table 2.1-2. BLM Land Use Allocations by Alternative[a,b]

Planning Area State	BLM Planning Area	No Action Alternative			Alternative 1		Alternative 2		Alternative 3			Alternative 4			Alternative 5		
										Exclusion Areas			Exclusion Areas			Exclusion Areas	
		Priority Areas[b]	Lands Available for Application (variance areas in six-state area)[c]	Exclusion Areas	Lands Available for Application	Resource-Based Exclusion Areas	Lands Available for Applica-tion	Resource-Based Exclusion Areas	Lands Available for Application	Resource-Based Exclusion Areas	Additional Areas Not Meeting Transmis-sion Proximity Criteria	Lands Available for Application	Resource-Based Exclusion Areas	Additional Areas Not Meeting Disturbed-Lands Criteria	Lands Available for Application	Resource-Based Exclusion Areas	Additional areas Not Meeting Transmission Proximity or Disturbed-Lands Criteria
Arizona	12,109,337	198,948	2,861,429	9,048,960	4,886,293	7,223,044	3,285,400	8,823,937	2,292,321	8,861,753	955,263	887,183	8,823,937	2,398,218	725,628	8,861,753	2,521,955
California	4,150,345	0	117,933	4,032,412	1,145,205	3,005,140	220,088	3,930,257	157,698	3,932,003	60,664	116,417	3,930,257	103,671	89,258	3,932,003	129,084
Colorado	8,354,306	22,038	135,548	8,196,717	2,281,931	6,072,374	813,551	7,540,775	548,225	7,561,299	244,782	329,854	7,540,755	483,697	235,270	7,561,299	557,738
Idaho	11,774,992	0	7,055,043	4,719,949	2,650,929	9,124,063	1,835,601	9,939,392	1,473,202	10,005,023	296,767	942,187	9,939,392	893,414	866,830	10,005,023	903,139
Montana	8,043,025	0	4,011,886	4,031,139	1,229,774	6,813,252	715,863	7,327,163	209,796	7,328,457	504,772	513,232	7,327,163	202,631	149,389	7,328,457	565,179
Nevada	47,272,125	61,834	6,863,590	40,346,702	18,332,220	28,939,905	12,371,628	34,900,497	6,988,748	35,096,891	5,186,487	2,424,286	34,900,497	9,947,342	1,587,446	35,096,891	10,587,789
New Mexico	13,493,392	29,716	3,915,370	9,548,306	6,301,088	7,192,304	5,000,154	8,493,238	2,987,559	8,525,548	1,980,285	1,765,014	8,493,238	3,235,140	1,301,315	8,525,548	3,666,529
Oregon	15,718,197	0	10,965,383	4,752,813	2,553,861	13,164,335	1,125,451	14,592,746	714,957	14,611,765	391,475	408,071	14,592,746	717,380	308,340	14,611,765	798,093
Utah	22,767,896	17,659	1,815,742	20,934,494	9,883,743	12,884,153	6,562,857	16,205,038	3,768,382	16,273,746	2,725,767	1,938,117	16,205,038	4,624,740	1,570,779	16,273,746	4,923,370
Washing-ton	437,237	0	412,062	25,175	355,229	82,008	125,135	312,103	106,458	312,103	18,676	94,975	312,103	30,159	81,211	312,103	43,923
Wyoming	18,047,498	0	9,139,769	8,907,717	5,417,541	12,629,957	4,124,996	13,922,502	2,980,130	13,971,708	1,095,661	1,779,148	13,922,502	2,345,848	1,444,249	13,971,708	2,631,541
TOTAL	162,168,351	330,195	47,293,756	114,544,384	55,037,816	107,130,534	36,180,723	125,987,628	22,227,475	126,480,296	13,460,580	11,198,484	125,987,629	24,982,238	8,359,715	126,480,295	27,328,341

[a] All areas are in acres; all alternatives exclude lands subject to the California DRECP (approximately 27 million acres). The total acres associated with the resource-based exclusions differ slightly for Alternative 2 and Alternatives 3–5. This difference occurs because parcels 20 acres or smaller are not included in the calculation. When exclusions are applied under Alternatives 3–5, certain parcels that were identified as larger than 20 acres for Alternative 2 are split, resulting in a small difference in the calculated resource-based exclusion areas.

[b] Lands allocations are best estimates. The geographic boundaries for exclusion categories will change over time as land use plans are revised or amended and new information on resource conditions is developed.

[c] The No Action Alternative includes SEZs as amended, REDAs (Renewable Energy Development Areas; BLM 2013a), Solar Emphasis Areas in Colorado (BLM 2015a), and the Dry Lake East Designated Leasing Area (DLA; BLM 2019a). The total priority area in each state has been updated to reflect changes implemented since 2012 (see Section 1.3). Under Alternatives 1 through 5, the priority areas are the same as under the No Action Alternative, except that the Los Mogotes SEZ in Colorado and the REDAs would be removed.

[d] Lands available for application under the No Action Alternative include existing variance lands in Arizona, California, Colorado, Nevada, New Mexico, and Utah. In Idaho, Montana, Oregon, Washington, and Wyoming, which were not part of the Western Solar Plan, lands available include all lands that are not otherwise excluded in existing land use plans.

Of the five Action Alternatives, Alternative 1 opens the most lands for application. Alternative 1 would make approximately 55 million acres across the 11-state planning area available for utility-scale ROW application. This alternative responds to commenters who have suggested BLM-administered lands should either be open or closed and that the BLM should not seek to identify more precisely the areas available for solar applications (as it did previously by identifying SEZs under the Western Solar Plan). As a percentage of the planning area, Alternative 1 would open 35% of the planning area to application and exclude solar energy application in the remaining 65% of the planning area (Figure 2.1-1). Only 1% of the lands available for application would be needed to meet the RFDS projection of lands needed for development (see Section 2.2). The lands available for solar application under this alternative are shown in Figure 2.1-2.

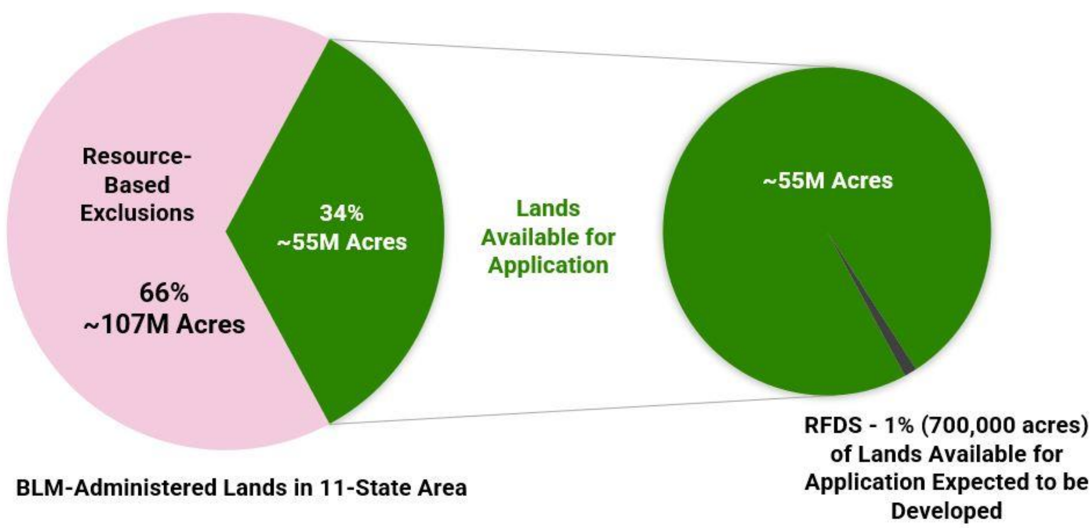
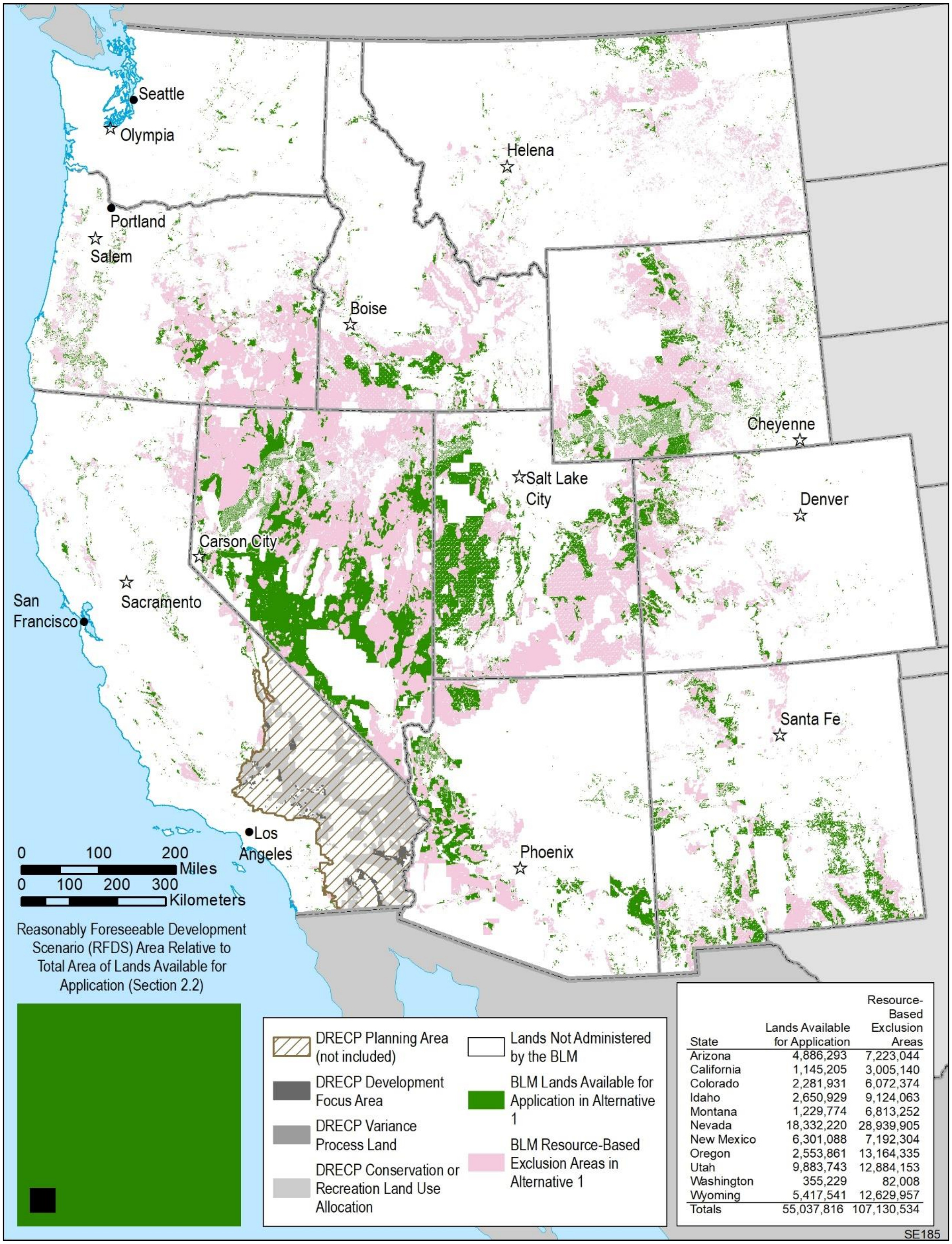


Figure 2.1-1. Relative Areas of BLM-Administered Lands Excluded and Available for Application Under Alternative 1.



State	Lands Available for Application	Resource-Based Exclusion Areas
Arizona	4,886,293	7,223,044
California	1,145,205	3,005,140
Colorado	2,281,931	6,072,374
Idaho	2,650,929	9,124,063
Montana	1,229,774	6,813,252
Nevada	18,332,220	28,939,905
New Mexico	6,301,088	7,192,304
Oregon	2,553,861	13,164,335
Utah	9,883,743	12,884,153
Washington	355,229	82,008
Wyoming	5,417,541	12,629,957
Totals	55,037,816	107,130,534

Figure 2.1-2. BLM-Administered Lands Excluded and Available for Application in the 11-State Planning Area Under Alternative 1.

2.1.1.2 Alternative 2: Resource-Based Exclusion Criteria and >10% Slope Lands Excluded

As in Alternative 1, BLM-administered lands would be excluded from utility-scale solar energy application under the resource-based exclusion criteria identified in Table 2.1-3. In addition, lands with greater than 10% slope would be excluded under this alternative.

Although the BLM is not including a technology-based slope exclusion for any of the Action Alternatives, the BLM received extensive comments during the scoping process for the Programmatic EIS supporting the retention of a slope exclusion criterion to avoid resource impacts such as increased erosion and impacts on cultural resources, surface hydrology, Tribal interests, visual resources, and wildlife and wildlife movement. In light of these concerns regarding elimination of the slope criterion, the BLM proposes to retain a criterion for all alternatives except Alternative 1. Consistent with many comments, the BLM proposes to set that limitation at 10%.

Alternative 2 responds to comments that suggested BLM-administered lands should either be open or closed and that the BLM should not seek to identify more precisely the areas available for solar applications (like the SEZs). Alternative 2 takes a similar approach to Alternative 1, but protects substantially more land by applying a general resource-based slope exclusion (i.e., lands with >10% slope would be excluded), which avoids impacts potentially associated with development on higher slopes.

Alternative 2 would make approximately 36 million acres across the 11-state planning area available for utility-scale ROW application. As a percentage of the planning area, Alternative 2 would open 22% of the planning area to application and exclude solar energy application in the remaining 78% (Figure 2.1-3). Only 2% of the lands available for application would be needed to meet the RFDS projection of lands needed for development (see Section 2.2). The lands available for solar application under this alternative are shown in Figure 2.1-4.

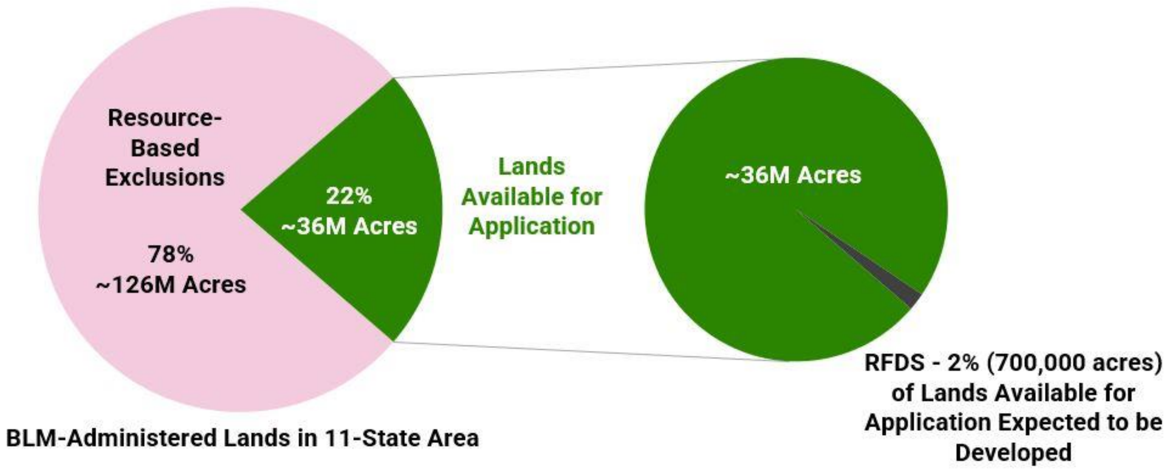
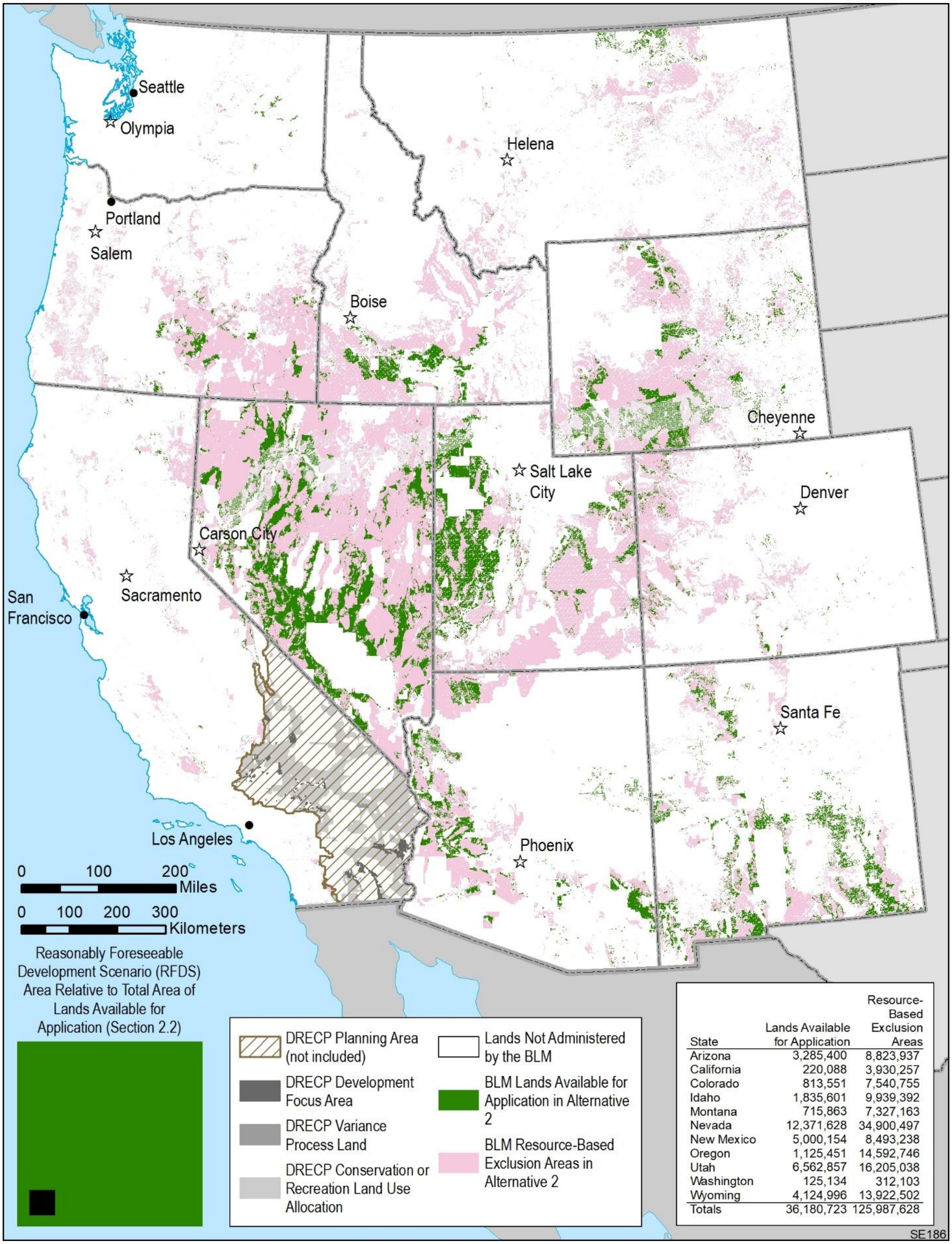


Figure 2.1-3. Relative Areas of BLM-Administered Lands Excluded and Available for Application Under Alternative 2.



State	Lands Available for Application	Resource-Based Exclusion Areas
Arizona	3,285,400	8,823,937
California	220,088	3,930,257
Colorado	813,551	7,540,755
Idaho	1,835,601	9,939,392
Montana	715,863	7,327,163
Nevada	12,371,628	34,900,497
New Mexico	5,000,154	8,493,238
Oregon	1,125,451	14,592,746
Utah	6,562,857	16,205,038
Washington	125,134	312,103
Wyoming	4,124,996	13,922,502
Totals	36,180,723	125,987,628

Figure 2.1-4. BLM-Administered Lands Excluded and Available for Application in the 11-State Planning Area Under Alternative 2.

2.1.1.3 Alternative 3: Transmission Proximity (Preferred Alternative)

Alternative 3 focuses on proximity to transmission infrastructure and is the BLM's preferred alternative (see Section 2.5). As under Alternative 2, lands would be excluded from utility-scale solar energy application under resource-based exclusion criteria identified in Table 2.1-3 and a general resource-based slope exclusion (>10% slope). Solar application areas would be identified as remaining areas within 10 miles on both sides of existing and planned transmission lines with capacities of 100 kV or greater.[6,7] Solar application areas would also include areas proximate to (i.e., within 10 miles of) the centerline of most Section 368 energy corridors (for further discussion, see Appendix J, Section J.1.5.1). Remaining BLM-administered lands farther than 10 miles from these transmission lines would not be available for solar applications.

Many solar projects sited on public lands are located in proximity to (less than 3 miles from) existing or planned transmission line infrastructure. Alternative 3 would facilitate co-locating rights-of-way to prevent transmission infrastructure sprawl across public lands while also limiting impacts on resources. This alternative would allow future utilization of additional transmission capacity that may become available. The BLM considered also including lands in proximity to substations (existing and planned) in this alternative but determined that including substations would be redundant with simply framing the alternative in terms of proximity to transmission lines because substations are generally located close to transmission lines.

If the BLM were to receive a proposal for a solar project further than 10 miles from existing or planned transmission (thus in an exclusion area under this alternative), the BLM would still have the discretion to consider the proposed solar project (and any associated transmission infrastructure) through evaluation of a land use plan amendment that would make available for solar energy application any necessary land not already available. The BLM will review solar energy development right-of-way applications for land use plan conformance. In cases where solar energy development proposals are not in conformance with an existing BLM land use plan adopted as part of this alternative because the project site is not within 10 miles of transmission, the BLM may choose to amend the existing land use plan concurrently with processing the application using the same environmental review process. Solar energy development applications that would require minor amendments to identify the specific site as suitable for utility-scale solar energy development may be permissible; however, processing of solar energy development applications that would require major land use plan revisions will be avoided.

6 Planned transmission line projects that cross BLM-administered lands (as listed in Appendix J, Table J-5) and areas within 10 miles of Section 368 corridors designated to accommodate aboveground development (except for Corridors of Concern; see Section J.1.5.1) are included.

7 Transmission capacity is the amount of electricity that can be transmitted along a single line. Lower-capacity lines are less efficient, losing more power when transporting electricity over longer distances. Transmission lines with capacities less than 100 kV are relatively minor components of the transmission grid (NERC 2018).

If new transmission lines not currently anticipated are approved by the BLM in the future, the BLM could choose to amend relevant land use plans to make lands within a 10-mile proximity to the transmission line right-of-way available for solar applications absent any other compelling resource exclusion criteria. The BLM expects that the lead office processing the transmission right-of-way application could leverage this Programmatic EIS, once finalized, by either supplementing it or tiering to it in the course of NEPA analysis to support such an amendment.

The intent of this alternative is to focus applications into areas near existing or planned transmission lines and energy load centers while still protecting high-value resources, thus reducing habitat fragmentation, natural resource disturbance, and environmental and cultural resource impacts. This alternative responds to the extensive public comment stating that areas must be near transmission resources to be viable for development while excluding and thereby preserving for other uses areas less desirable for development.

Alternative 3 would make approximately 22 million acres across the 11-state planning area available for utility-scale ROW application. As a percentage of the planning area, Alternative 3 would open 14% of the planning area to application and exclude solar energy application in the remaining 86% (Figure 2.1-5). The lands in 78% of the planning area would be excluded under resource-based exclusion criteria; an additional 8% of the planning area that is more than 10 miles from transmission lines would be closed to solar applications as well. Only 3% of the lands available for application would be needed to meet the RFDS projection of lands needed for development (see Section 2.2). The lands available for application under Alternative 3 are shown in Figure 2.1-6.

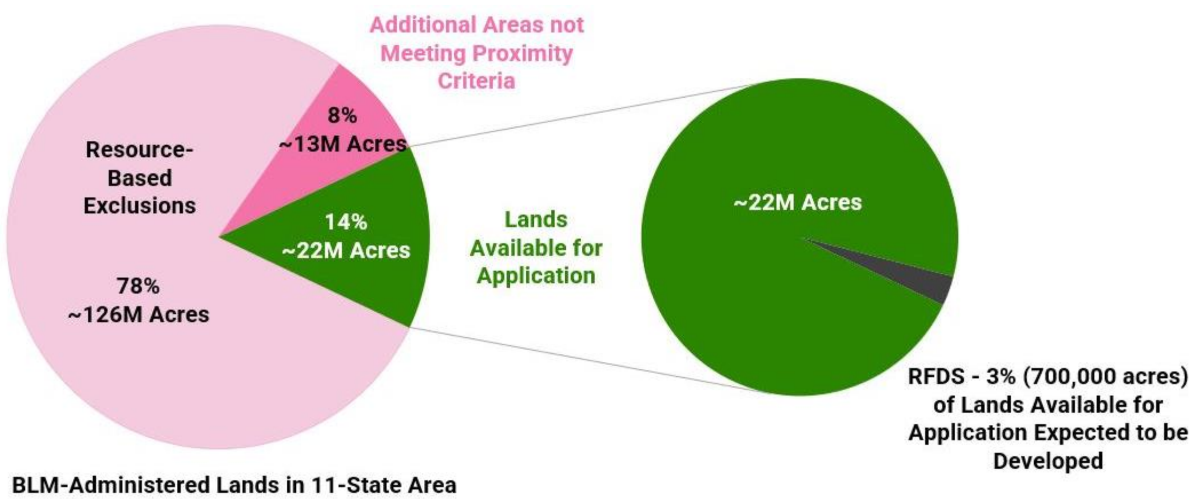
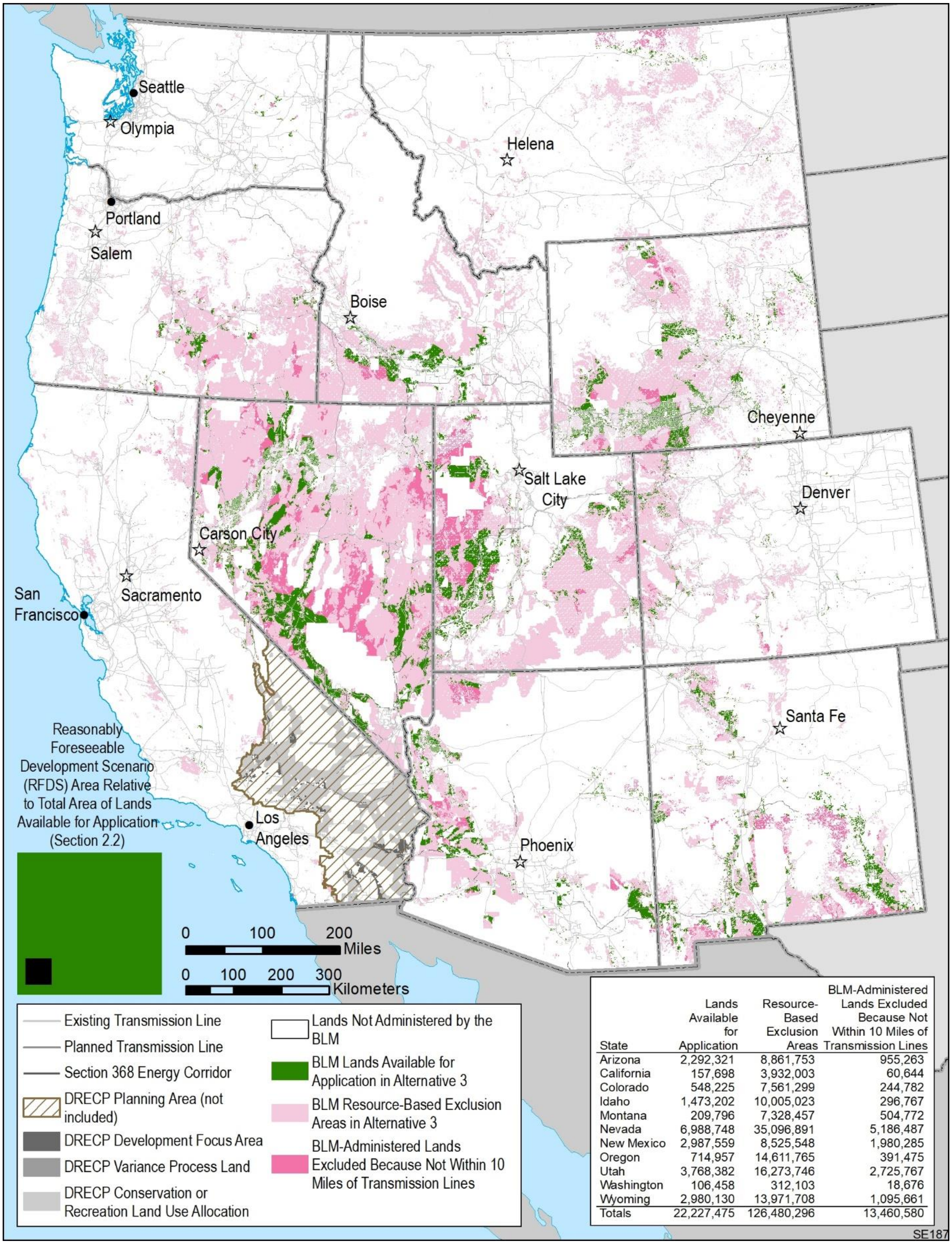


Figure 2.1-5. Relative Areas of BLM-Administered Lands Excluded and Available for Application Under Alternative 3.



State	Lands Available for Application	Resource-Based Exclusion Areas	BLM-Administered Lands Excluded Because Not Within 10 Miles of Transmission Lines
Arizona	2,292,321	8,861,753	955,263
California	157,698	3,932,003	60,644
Colorado	548,225	7,561,299	244,782
Idaho	1,473,202	10,005,023	296,767
Montana	209,796	7,328,457	504,772
Nevada	6,988,748	35,096,891	5,186,487
New Mexico	2,987,559	8,525,548	1,980,285
Oregon	714,957	14,611,765	391,475
Utah	3,768,382	16,273,746	2,725,767
Washington	106,458	312,103	18,676
Wyoming	2,980,130	13,971,708	1,095,661
Totals	22,227,475	126,480,296	13,460,580

Figure 2.1-6. BLM- Administered Lands Excluded and Available for Application in the 11-State Planning Area Under Alternative 3.

2.1.1.4 Alternative 4: Previously Disturbed Lands

Alternative 4 focuses on previously disturbed lands. As under Alternatives 2 and 3, lands would be excluded from utility-scale solar energy application under resource-based exclusion criteria listed in Table 2.1-3 and a general resource-based slope exclusion (>10% slope).

Solar application areas would be remaining areas identified as previously disturbed lands, which generally have diminished resource integrity based on the U.S. Geological Survey (USGS) Landscape Intactness model (Carter et al. 2017). In addition to the resource exclusion criteria under all alternatives, this alternative utilizes the USGS study, combined with data related to herbaceous vegetation cover, to develop a macro-scale strategy to avoid and minimize potential adverse consequences of development on public lands. Under this alternative, the BLM would allocate solar application areas where previously disturbed lands have been identified on the basis of a substantial departure from baseline resource conditions according to the USGS Landscape Intactness model, or where the presence of invasive annual weeds at pixel densities greater than 40% is estimated based on the general assumption that lands with invasive weeds at this level or greater would encounter substantial challenges to restoration. Lands with less than 40% annual weed cover would be excluded from solar energy development, thereby preserving these lands for potential future restoration, as appropriate. Annual herbaceous cover data prepared by the Multi-Resolution Land Characteristics (MRLC) consortium are being used as a proxy for the degree of presence of invasive weeds (MRLC 2023). The BLM anticipates this alternative would result in more efficient application reviews and more environmentally responsible solar energy development, because development would be focused on disturbed or degraded lands and avoid sensitive resources.

The intent of Alternative 4 is to limit impacts associated with utility-scale solar energy projects on undisturbed lands. Alternative 4 would make approximately 11 million acres across the 11-state planning area available for application. As a percentage of the planning area, Alternative 4 would open 7% of the planning area to application and exclude solar energy application in the remaining 93% (Figure 2.1-7). Only 6% of the lands available for application would be needed to meet the RFDS projection of lands needed for development (see Section 2.2). Like Alternatives 2 and 3, the lands in 78% of the planning area would be excluded under resource-based exclusion criteria; an additional 15% of the planning area that is of moderate or high intactness or with invasive weeds present at less than 40% would also be closed to solar applications. The lands available for application under Alternative 4 are shown in Figure 2.1-8.

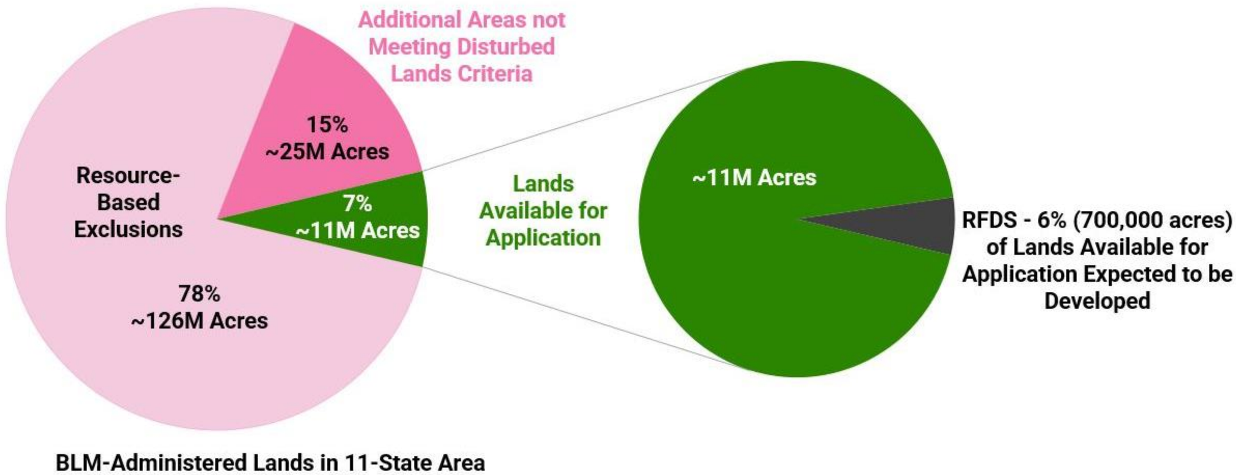
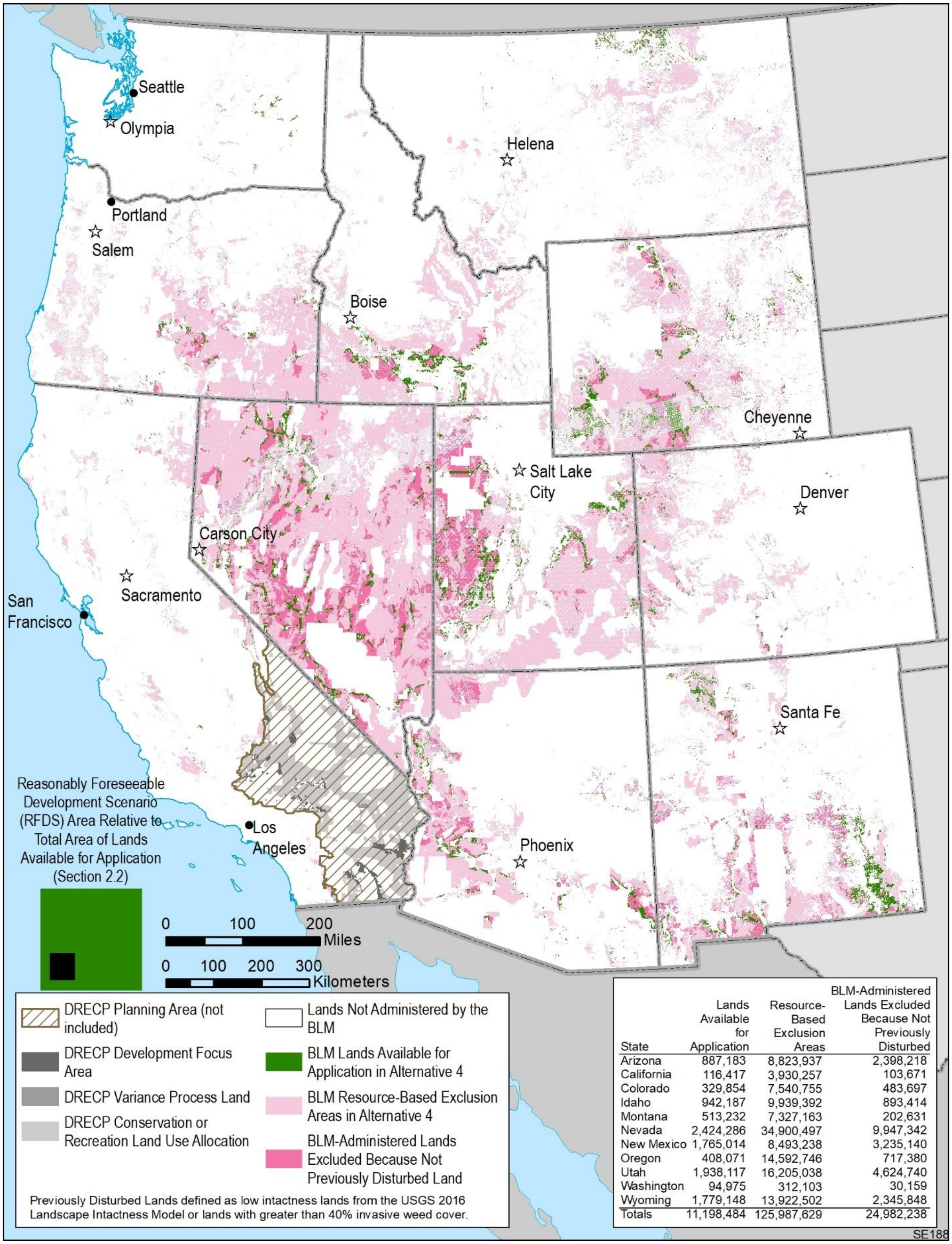


Figure 2.1-7. Relative Areas of BLM-Administered Lands Excluded and Available for Application Under Alternative 4.



State	Lands Available for Application	Resource-Based Exclusion Areas	BLM-Administered Lands Excluded Because Not Previously Disturbed
Arizona	887,183	8,823,937	2,398,218
California	116,417	3,930,257	103,671
Colorado	329,854	7,540,755	483,697
Idaho	942,187	9,939,392	893,414
Montana	513,232	7,327,163	202,631
Nevada	2,424,286	34,900,497	9,947,342
New Mexico	1,765,014	8,493,238	3,235,140
Oregon	408,071	14,592,746	717,380
Utah	1,938,117	16,205,038	4,624,740
Washington	94,975	312,103	30,159
Wyoming	1,779,148	13,922,502	2,345,848
Totals	11,198,484	125,987,629	24,982,238

Figure 2.1-8. BLM-Administered Lands Excluded and Available for Application in the 11-State Planning Area Under Alternative 4.

2.1.1.5 Alternative 5: Previously Disturbed Lands and Transmission Proximity

Alternative 5 combines the focus of Alternatives 3 and 4 and identifies lands as available for solar application if they are both near transmission infrastructure and previously disturbed. As under Alternatives 2-4, lands would be excluded from utility-scale solar energy application under resource-based exclusion criteria listed in Table 2.1-3 and a general resource-based slope exclusion (>10% slope).

Solar application areas would be areas that are within (1) 10 miles of existing and planned transmission lines with capacities of 100 kV or greater (as described above for Alternative 3) and (2) previously disturbed (as described above for Alternative 4). Remaining lands that are more than 10 miles from transmission lines or have moderate or high intactness and invasive weeds present at less than 40% and not otherwise excluded would not be available for solar applications.

The intent of this alternative is to limit impacts associated with utility-scale solar energy projects to undisturbed lands, and to focus development into areas close to the transmission grid. This alternative combines the environmental benefits of Alternatives 3 and 4.

Alternative 5 would make approximately 8 million acres across the 11-state planning area available for utility-scale ROW application. As a percentage of the planning area, Alternative 5 would open 5% of the planning area to application and exclude solar energy application in the remaining 95% (Figure 2.1-9). Only 8% of the lands available for application would be needed to meet the RFDS projection of lands needed for development (see Section 2.2). The lands in 78% of the planning area would be excluded under resource-based exclusion criteria; 17% of the planning area that is either more than 10 miles from transmission lines or has higher levels of intactness would be closed to solar applications. The lands available for application under Alternative 5 are shown in Figure 2.1-10.

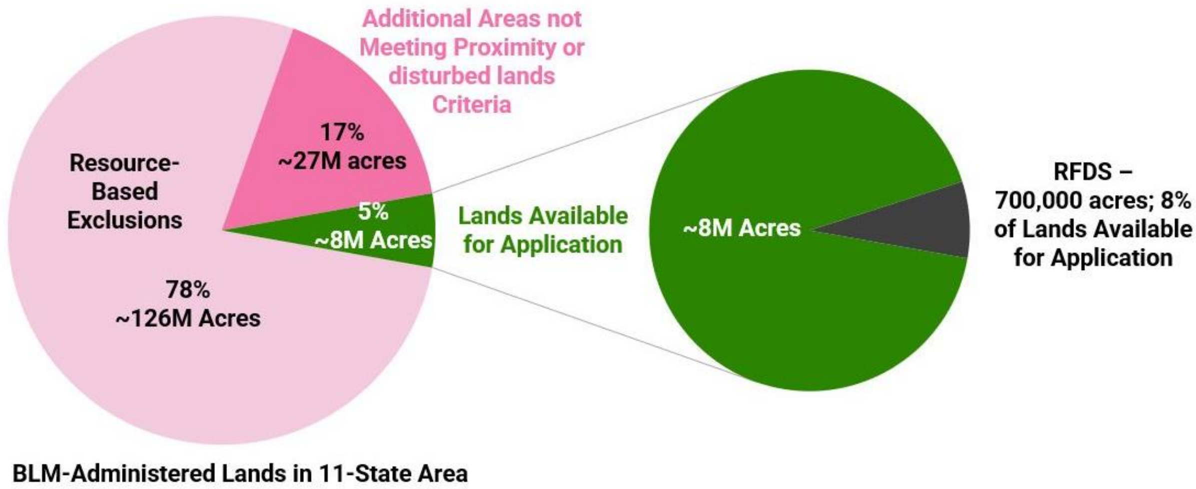
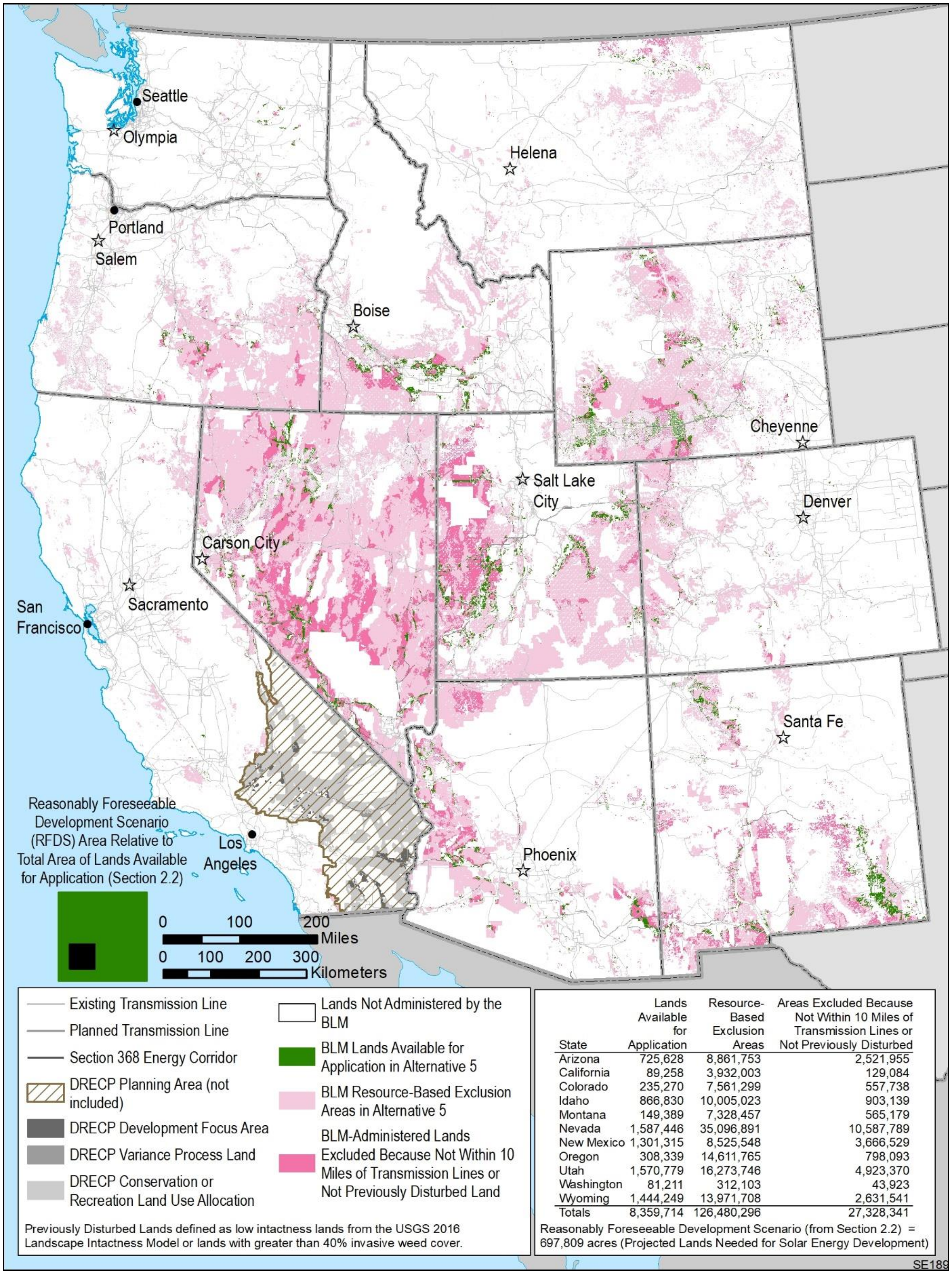


Figure 2.1-9. Relative Areas of BLM-Administered Lands Excluded and Available for Application Under Alternative 5.



State	Lands Available for Application	Resource-Based Exclusion Areas	Areas Excluded Because Not Within 10 Miles of Transmission Lines or Not Previously Disturbed
Arizona	725,628	8,861,753	2,521,955
California	89,258	3,932,003	129,084
Colorado	235,270	7,561,299	557,738
Idaho	866,830	10,005,023	903,139
Montana	149,389	7,328,457	565,179
Nevada	1,587,446	35,096,891	10,587,789
New Mexico	1,301,315	8,525,548	3,666,529
Oregon	308,339	14,611,765	798,093
Utah	1,570,779	16,273,746	4,923,370
Washington	81,211	312,103	43,923
Wyoming	1,444,249	13,971,708	2,631,541
Totals	8,359,714	126,480,296	27,328,341

Reasonably Foreseeable Development Scenario (from Section 2.2) = 697,809 acres (Projected Lands Needed for Solar Energy Development)

Figure 2.1-10. BLM-Administered Lands Excluded and Available for Application in the 11-State Planning Area Under Alternative 5.

2.1.1.6 Exclusion Criteria Under the Action Alternatives

Under each of the Action Alternatives, lands would be excluded from solar energy application using various resource-based exclusion criteria, which are presented in Table 2.1-3. For this Solar Programmatic EIS, the exclusion criteria adopted under the Western Solar Plan have been reviewed and updated, taking into account BLM experience to date in permitting and monitoring PV solar energy facilities, as well as public and cooperating agency input.

The extent of the land area excluded by application of those criteria will change over time as land use plans are revised or amended and new information on resource conditions is developed. For example, under Criterion 2, which excludes critical habitat for species protected under the ESA, if a new species is listed in the future, the critical habitat for that species would be excluded upon its designation. The maps for the Action Alternatives presented in Section 2.1.1 reflect the exclusion criteria to the extent that available GIS data allow, although some resource exclusions remain unmapped due to information sensitivity or lack of complete geospatial data for the 11-state planning area. Lands are excluded if they satisfy any one of the exclusion criteria regardless of whether they are shown to be part of exclusion areas mapped based on GIS data.

Table 2.1-3. Proposed Resource-Based Exclusion Criteria Common to All Action Alternatives

Exclusion No.	Exclusion Name	Exclusion Description	Exclusion Status for Alternatives Analysis [a]
1	Areas of Critical Environmental Concern (ACECs)	All ACECs identified in applicable land use plans.	Mapped
2	Threatened and Endangered Species	All designated and proposed critical habitat areas for species protected under the ESA (https://ecos.fws.gov/ecp/report/critical-habitat). Known occupied habitat for ESA-listed species, based on current available information or surveys of project areas.[b]	Partially mapped
3	Lands with Wilderness Characteristics	All areas for which an applicable land use plan establishes protection for lands with wilderness characteristics.	Partially mapped
4	Recreation	Developed recreational facilities and all Special Recreation Management Areas (SRMAs) identified in applicable land use plans .[c]	Mapped
5	Habitat Areas	Dixie valley toad habitat, Wyoming toad habitat, and Carson wandering skipper habitat. All areas where the BLM has agreements with USFWS and/or state agency partners and other entities to manage sensitive species habitat in a manner that would preclude solar energy development, including habitat protection and other recommendations in conservation agreements/strategies.	Unmapped
6	Greater Sage-Grouse and Gunnison Sage-Grouse	Greater sage-grouse and Gunnison sage-grouse habitat as identified for exclusion in applicable land use plans.[d]	Mapped

Exclusion No.	Exclusion Name	Exclusion Description	Exclusion Status for Alternatives Analysis [a]
7	Land Use Designations	All areas designated as no surface occupancy (NSO) in applicable land use plans. All ROW exclusion areas identified in applicable land use plans. All ROW avoidance areas identified in applicable land use plans to the extent the purpose of the ROW avoidance is incompatible with solar energy development.	Mapped
8	Desert Tortoise	All desert tortoise translocation sites identified in applicable resource management plans, project-level mitigation plans, or Biological Opinions.	Unmapped
9	Big Game	All big game migratory corridors identified in applicable land use plans to the extent the land use plan decision prohibits utility-scale solar energy development. All big game winter ranges identified in applicable land use plans to the extent the land use plan decision prohibits utility-scale solar energy development.	Unmapped
10	Natural Areas and Other Conservation Areas	Research Natural Areas and Outstanding Natural Areas identified in applicable land use plans.[e] All Backcountry Conservation Areas identified in applicable land use plans.	Partially mapped
11	Visual Resources	Lands classified as visual resource management (VRM) Class I or II throughout the 11-state planning area and, only in Utah (and small parts of Arizona and Colorado), some lands classified as Class III[f] in applicable land use plans.	Mapped
12	National Scenic Byways	All National Scenic Byways, including all BLM Back Country Byways (BLM State Director approved) identified in applicable BLM land use plans, including any associated corridor or lands identified for protection through an applicable land use plan.	Unmapped
13	National Recreation, Water, or Side and Connecting Trails	All Secretarially designated National Recreation Trails (including National Water Trails) and Connecting and Side Trails identified in applicable BLM and local land use plans, including any associated corridor or lands identified for protection through an applicable land use plan.	Unmapped
14	National Conservation Lands	All units of BLM National Conservation Lands: • National Monuments • National Conservation Areas and other areas similarly designated for conservation, including Cooperative Management and Protection Areas, Outstanding Natural Areas,[e] Forest Reserves, and National Scenic Areas. • National Trails System • All National Scenic and Historic Trails designated by Congress, trails recommended as suitable for designation through a congressionally authorized National Trail Feasibility Study, or such qualifying trails identified as additional routes in law, including any trail management corridors identified for protection through an applicable land use plan,[g]	Mapped

Exclusion No.	Exclusion Name	Exclusion Description	Exclusion Status for Alternatives Analysis [a]
		• Trails undergoing a Congressionally authorized National Trail Feasibility Study will also be excluded pending the outcome of the study. • National Wild and Scenic Rivers: • All designated Wild and Scenic Rivers, including any associated corridor and lands identified for protection through an applicable river corridor plan (or comprehensive river management plan). Absent a river plan, protection corridors are ¼ mile to either side of the river from the ordinary high-water mark, unless otherwise provided by law. • Areas outside a designated wild and scenic river corridor when the project would “invade the area or unreasonably diminish” the wild and scenic river’s river values. • All segments of rivers determined to be eligible or suitable for Wild or Scenic River status as identified in applicable land use plans, including any associated corridor and lands identified for protection through an applicable land use plan. • Wilderness Areas and Wilderness Study Areas	
15	National Natural Landmarks	National Natural Landmarks identified in applicable land use plans, including any associated lands identified for protection through an applicable land use plan.	Mapped
16	*National Register of Historic Places* (NRHP)	Lands within the boundaries of properties listed in the NRHP, including National Historic Landmarks, and any additional lands outside the designated boundaries identified for protection through an applicable land use plan.	Partially mapped
17	Tribal Interest Areas	Traditional cultural properties (TCPs) and Native American sacred sites that are identified through consultation with Tribes and recognized by the BLM or that are the subject of a Memorandum of Understanding between the BLM and a Tribe or Tribes.	Partially mapped
18	Old Growth Forests	Old Growth Forests identified in applicable land use plans.	Unmapped
19	Lands Previously Found to Be Inappropriate for Solar Energy Development	Lands found to be inappropriate for solar energy development through a prior environmental review process.[h]	Mapped
20	Acquired Lands	All lands acquired by the BLM using funds from the Land and Water Conservation Fund or the Southern Nevada Public Land Management Act, as amended (Public Law 105-263).	Mapped
21	State- or Area-Specific	In Nevada, lands in the Ivanpah Valley, Coal Valley, and Garden Valley. Area surrounding Chaco Culture National Historical Park consistent with Public Land Order No. 7923. Rio Grande Natural Area (as established by Public Law 109-337).	Mapped

[a] For this Programmatic EIS, the alternatives analysis either: incorporated publicly available geospatial data across the 11-state decision area (mapped); did not incorporate geospatial data – these exclusions would be mapped at the project-specific level (unmapped); or incorporated some geospatial data for the study area as available but some exclusion areas would be mapped at the project-specific level (partially mapped). Details on geospatial data included in the analysis are provided in Appendix G. The

extent of the land area excluded by application of exclusion criteria will change over time as land use plans are revised or amended and new information on resource conditions is developed.

[b] Available spatial data for designated and proposed critical habitat is mapped for the alternatives in this Programmatic EIS. Occupied habitat for ESA-listed species (including threatened, endangered, and experimental nonessential populations) is excluded but is unmapped for this Solar Programmatic EIS. Where solar applications are proposed within the range of ESA-listed species, occupied habitat would be required to be mapped and excluded during project-specific evaluations, in coordination with the USFWS. The exclusion applies to all occupied habitat for all ESA-listed species including the following: Autumn buttercup, Barneby reed-mustard, Blowout penstemon, Clay reed-mustard, Clay-Loving Wild Buckwheat, Colorado hookless cactus, DeBeque Phacelia, desert yellowhead, Dudley Bluffs Bladderpod, Dudley Bluffs Twinpod, Dwarf Bear Poppy, Gierisch mallow, Gypsum wild buckwheat, Holmgren milkvetch, Jones cycladenia, Kendall warm springs dace, Knowlton's cactus, Last chance townsendia, Lee pincushion cactus, lesser prairie chicken, Mancos milk-vetch, Mesa Verde cactus, Mexican spotted owl (within 0.5 miles of Protected Activity Centers), North Park phacelia, Northern long-eared bat, Osterhout milkvetch, Pagosa skyrocket, Pariette cactus, Pecos sunflower, Penland beardtongue, Preble's meadow jumping mouse, San Rafael cactus, Shivwits milkvetch, Shrubby reed-mustard, Siler pincushion cactus, Sneed pincushion cactus, Sonoran pronghorn, Todsen's pennyroyal, Uinta Basin hookless cactus, Utah prairie dog, Ute ladies'-tresses, Welsh's milkweed, Western yellow-billed cuckoo, Winkler cactus, Wright fishhook cactus, Colorado pikeminnow, Humpback chub, Razorback sucker, Bonytail, Mojave desert tortoise, Dixie Valley toad, Wyoming toad, Carson wandering skipper, Gunnison sage grouse, Black-footed ferret, Grizzly bear.

[c] Under this Solar Programmatic EIS, SRMAs in NV are mapped and would be excluded. Note that under the 2012 Western Solar Plan, SRMAs in Nevada are available for solar ROW application.

[d] **Greater sage-grouse**: The BLM amended or revised land use plans in 2014 and 2015 in the states of California, Colorado, Idaho, Montana, Nevada, North Dakota, Oregon, South Dakota, Utah, and Wyoming (2015 Sage-Grouse Plan Amendments) to provide for greater sage-grouse conservation on public lands. Subsequently, the BLM amended several of those plans in 2019 in the states of California, Colorado, Idaho, Nevada, Oregon, Utah, and Wyoming (BLM 2019b). On October 16, 2019, the United States District Court for the District of Idaho preliminarily enjoined the BLM from implementing the 2019 amendments (BLM 2019b) in Case No. 1:16-CV-83-BLW. The 2015 Sage-Grouse Plan Amendments, therefore, are currently in effect. To meet the objectives of BLM's sage-grouse conservation policy, the BLM has initiated a land use planning process to evaluate alternative management approaches to contribute to the conservation of greater sage-grouse and sagebrush habitats and to evaluate the impacts of any land use planning decisions directed toward greater sage-grouse and sagebrush habitat conservation (BLM 2023e). The land use planning process will address the management of greater sage-grouse and sagebrush habitat on BLM-managed public lands in the states of California, Colorado, Idaho, Montana, Nevada, North Dakota, Oregon, South Dakota, Utah, and Wyoming. See *Notice of Intent to Amend Land Use Plans Regarding Greater Sage-Grouse Conservation and Prepare Associated Environmental Impact Statements* (86 FR 66331). This exclusion is coextensive with the treatment of utility-scale solar energy development as provided in the 2015 Sage-Grouse Plan Amendments. The exclusion is also dynamic and subject to potential future changes to those plans. Therefore, because the BLM is evaluating the extent to which solar development should be excluded in sage-grouse habitat as part of its latest sage-grouse planning efforts, the scope of this exclusion may change.

Gunnison Sage-grouse: The BLM is preparing an EIS in support of a planning effort potentially to amend the land use plans of BLM field offices, national monuments, and national conservation areas containing occupied and unoccupied habitat for the threatened Gunnison sage-grouse (*Centrocercus minimus*) (BLM 2023f).). This exclusion is coextensive with the treatment of utility-scale solar energy development under applicable land use plans and so currently prohibits such development as provided in the 2015 Sage-Grouse Plan Amendments. The exclusion is also dynamic and subject to potential future changes to those plans. Therefore, because the BLM is reevaluating the extent to which solar development should be excluded in sage-grouse habitat as part of its latest sage-grouse planning efforts, the scope of this exclusion may change.

Bi-State Distinct Population Segment of Greater Sage-Grouse: This exclusion currently prohibits utility-scale solar energy development consistent with bi-state DPS greater sage-grouse exclusion areas in current land use plans and is subject to change based on the outcome of the BLM's sage-grouse planning efforts and resulting plan amendments.

[e] There are also Outstanding Natural Areas and Research Natural Areas administratively designated in land use plans. These are also excluded under a separate criterion for clarity.

[f] In Utah and small areas of Arizona and Colorado, VRM Class III lands that are within 25 miles of Zion, Bryce, Capital Reef, Arches, and Canyonlands National Parks would be excluded under this criterion due to the high sensitivity of these locations proximate to the national parks.

[g] National Scenic Trails comprise extended pathways located for recreational opportunities and the conservation and enjoyment of the scenic, historic, natural, and cultural qualities of the areas through which they pass (NTSA Sec. 3(a)(2)). National Historic Trails comprise Federal Protection Components and/or high-potential historic sites and high-potential route segments, including original trails or routes of travel, developed trail or access points, artifacts, remnants, traces, and the associated settings and primary uses identified and protected for public use and enjoyment (NTSA Sec. 3(a)(3)) and may include associated auto tour routes (NTSA Sec. 5(b)(A) and 7(c)). National Historic Trails or other types of historic trails may also contain properties listed or eligible for listing on the NRHP including as National Historic Landmarks. National Historic Trails are protected and identified as required by law (NTSA Sec. 3(a)(3)), through BLM inventory and planning processes.

[h] This criterion applies to lands considered non-developable in the environmental analyses completed for the Genesis Ford Dry Lake Solar Project, Blythe Solar Project, and Desert Sunlight Solar Project. This criterion also applies to lands determined to be inappropriate for solar energy development during preparation of the 2012 Western Solar Plan including parts of the Brenda SEZ in Arizona; the previously proposed Iron Mountain SEZ area and parts of the Pisgah and Riverside East SEZs in California; parts of the De Tilla Gulch, and Los Mogotes East SEZs in Colorado; parts of the Amargosa Valley SEZ in Nevada, and areas identified during consultation with cooperating agencies and Tribes excluded to protect sensitive natural, visual, and cultural resources (total of 1,066,497 acres [4,316 km^2]; see Western Solar Plan, Figure A-1). The entire Fourmile East SEZ in Colorado has been deallocated and is excluded. Note: This Programmatic EIS proposes deallocating the remaining area of the Los Mogotes East SEZ due to Tribal concerns.

2.1.1.7 Design Features under the Action Alternatives

The 2012 Western Solar Plan established design features applicable to all future utility-scale solar energy development on BLM-administered lands. Design features are project requirements that have been incorporated into the proposed action and other Action Alternatives to avoid, minimize, and/or compensate for adverse impacts. For this Programmatic EIS, the BLM reviewed the design features from the 2012 Western Solar Plan, taking into account BLM experience to date in permitting and monitoring PV solar energy facilities, as well as public and cooperating agency input, and updated them as appropriate. The proposed design features are presented in Appendix B by resource type and by project phase (i.e., general; site characterization, siting, design, and construction; operations and maintenance; and decommissioning/reclamation). These design features address resource conflicts associated with utility-scale solar energy development. In addition, projects on BLM-administered lands are required to follow all applicable federal, state, and local laws and regulations, such as the ESA, which will impose additional requirements that avoid and/or minimize resource impacts.

For those impacts that cannot be avoided or minimized, the BLM will consider implementing compensatory mitigation to offset impacts, with a goal of ensuring viability of resources over time. The BLM has previously taken action to compensate for impacts of solar energy development. For example, to address unavoidable residual impacts of solar energy development in SEZs, the BLM produced several regional mitigation strategies after the 2012 Western Solar Plan was established (BLM 2014; 2016c,d; 2017a), based on the framework for developing regional mitigation plans presented in Appendix A, Section A.2.5, of the 2012 Final Solar Programmatic EIS (BLM and DOE 2012). This regional mitigation strategy framework could be used, as appropriate, for the compensation of unavoidable residual impacts from solar energy development under any of the Action Alternatives in this Programmatic EIS.

2.1.1.8 Monitoring and Adaptive Management

The BLM's Assessment, Inventory, and Monitoring (AIM) Strategy for condition and trend monitoring of BLM-managed resources and lands has been in use for several years (Taylor et al. 2014). A long-term monitoring strategy incorporating the AIM strategy was developed for the Riverside East SEZ (BLM 2016b). The BLM supports the use of the AIM Strategy as the basis for long-term solar monitoring and adaptive management. The AIM Strategy provides a replicable, consistent framework for collecting monitoring data and for adaptively managing the siting and permitting of solar energy projects. Further, an AIM-based project- or region-specific long-term monitoring plan can take advantage of guidance and support available from BLM's AIM staff (BLM 2023c). The information derived from monitoring of solar energy development will provide understanding of the condition and trend of BLM-managed lands within and near solar energy projects located on BLM-administered land and can support informed decision-making across jurisdictional boundaries.

2.1.2 No Action Alternative

The No Action Alternative continues the management of utility-scale solar energy development in six southwestern states (Arizona, California, Colorado, Nevada, New Mexico, and Utah) as approved in the 2012 Western Solar Plan, as amended. That Plan excludes lands from utility-scale solar energy development, and designates SEZs as priority areas, specific locations well suited for utility-scale solar energy where the BLM prioritizes development.[6] The Western Solar Plan also allows for consideration of utility-scale solar energy development proposals on lands outside of SEZs in accordance with procedures in a variance process established in the plan decision. The Plan established programmatic design features for utility-scale solar energy development on BLM-administered lands. The Western Solar Plan amended the land use plans in the six-state planning area to reflect the identification of excluded lands, SEZs, and variance lands to facilitate permitting utility-scale (there defined as solar energy facilities with nameplate capacity of 20 MW or greater) solar energy generation projects. The specific categories of resource-based exclusions under the No Action Alternative are identified in Table 2.1-4. Additional exclusions are applied for lands with solar insolation levels less than 6.5 kWh/m^2/day and lands with slope >5%.

For the five states not subject to the Western Solar Plan, the No Action Alternative continues the status quo under which solar applications in those states are evaluated under the existing terms of approved resource management plans—for example, areas subject to an existing ROW exclusion are not available for solar applications.

The No Action Alternative maintains the existing designations of approximately 330,000 acres of priority areas, as amended, and approximately 16 million acres of variance areas. Another estimated 31 million acres are available for solar application in the five states not subject to the Western Solar Plan. Under the No Action Alternative, 29% of the decision area is available for solar ROW application while solar energy development is excluded in the remaining 71% (Figure 2.1-11). The lands available for solar application under the No Action Alternative are shown in Figure 2.1-12.

[6] Amendments to the 2012 Western Solar Plan include addition of the Agua Caliente SEZ in Arizona, the West Chocolate Mountain SEZ in California, the Dry Lake East DLA in Nevada, REDAs in Arizona, solar emphasis areas in Colorado; and deletion of the Fourmile East SEZ in Colorado, as detailed in Section 1.3.

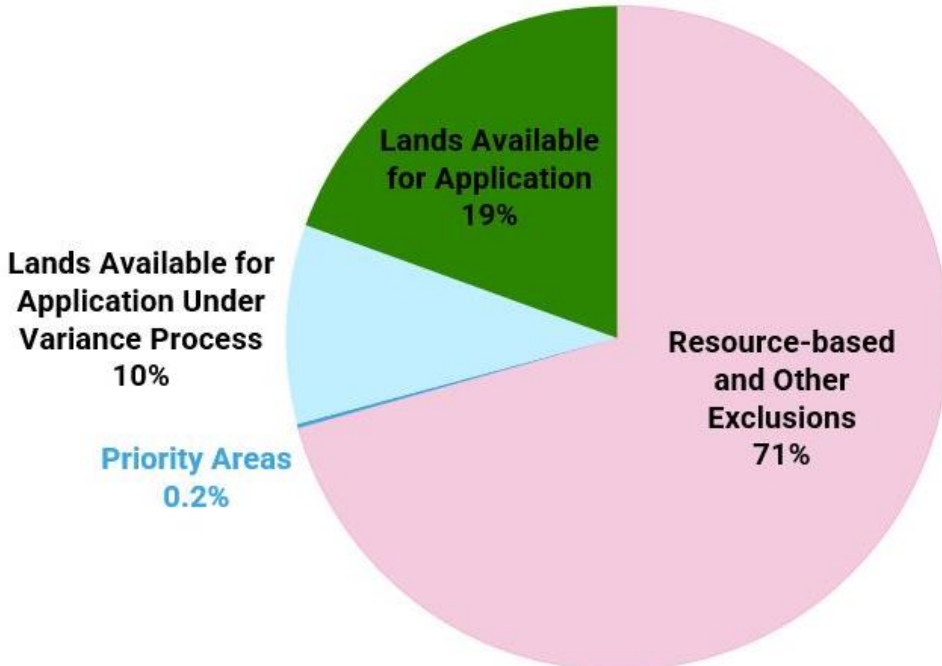
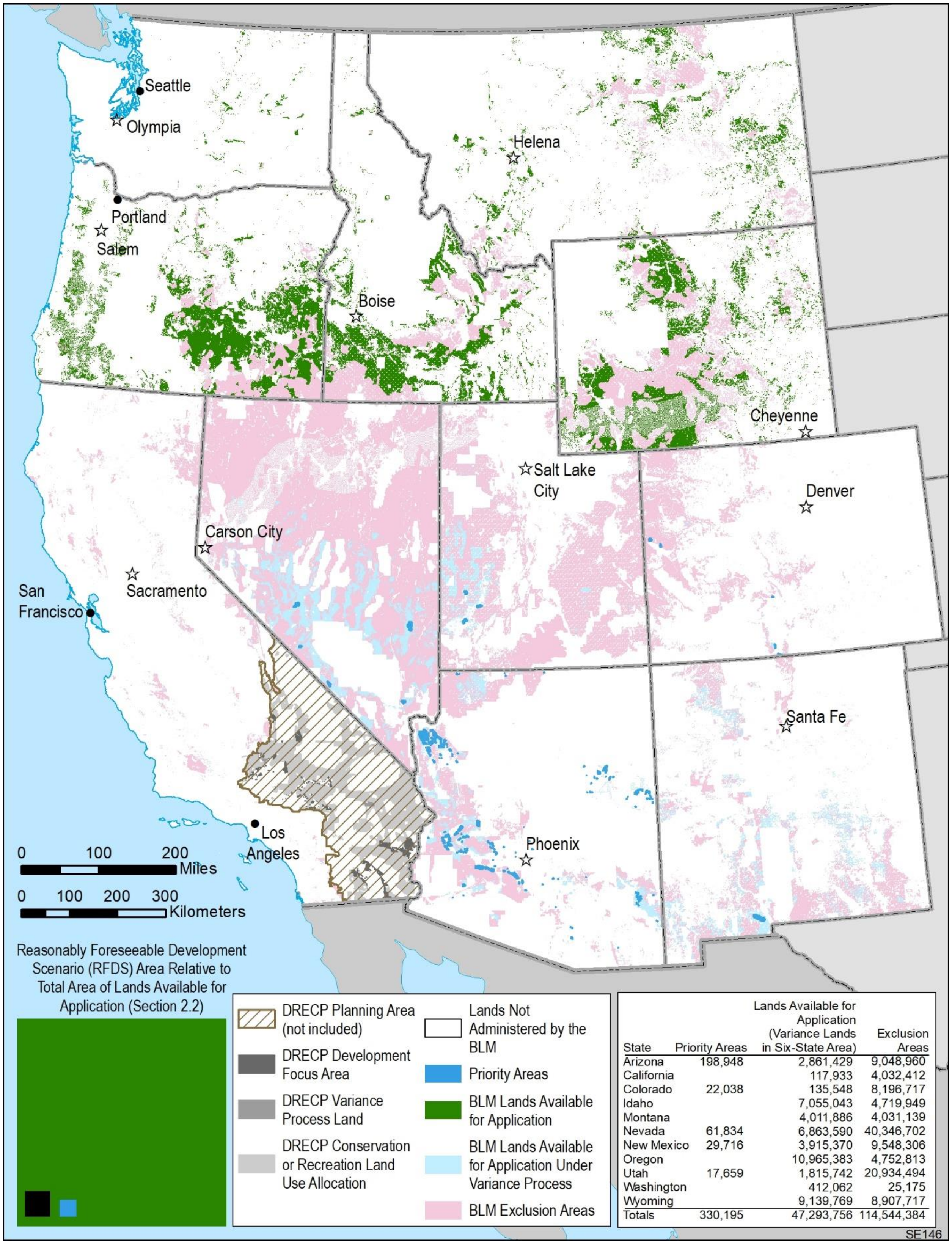


Figure 2.1-11. Relative Areas of BLM-Administered Lands Designated as Excluded, Priority Areas, Variance Lands, and Other Lands Available for Application Under the No Action Alternative.



State	Priority Areas	Lands Available for Application (Variance Lands in Six-State Area)	Exclusion Areas
Arizona	198,948	2,861,429	9,048,960
California		117,933	4,032,412
Colorado	22,038	135,548	8,196,717
Idaho		7,055,043	4,719,949
Montana		4,011,886	4,031,139
Nevada	61,834	6,863,590	40,346,702
New Mexico	29,716	3,915,370	9,548,306
Oregon		10,965,383	4,752,813
Utah	17,659	1,815,742	20,934,494
Washington		412,062	25,175
Wyoming		9,139,769	8,907,717
Totals	330,195	47,293,756	114,544,384

Figure 2.1-12. BLM-Administered Lands Designated as Priority Areas, Excluded, Variance, and Available for Application Under the No Action Alternative.

2.1.2.1 Exclusion Criteria Under the No Action Alternative

For the six states subject to the Western Solar Plan (Arizona, California, Colorado, Nevada, New Mexico, and Utah), the Plan identified categories of lands to be excluded (Table 2.1-4). Many of the exclusion categories used in the Western Solar Plan were defined by the identification of specific land use designations in applicable land use plans (e.g., ACECs) or the presence of a specific resource or condition (e.g., designated or proposed critical habitat for ESA-listed species). The geographic boundaries for such exclusion categories change over time as land use plans are revised or amended and new information on resource conditions is developed. Therefore, the exclusion, priority, and variance areas are not static and have changed since the Western Solar Plan was adopted. The maps for the No Action Alternative presented in this section reflect these updates to the extent possible, although some resource exclusions remain unmapped due to information sensitivity or lack of complete geospatial data.

The 2012 Western Solar Plan does not apply to Idaho, Montana, Oregon, Washington, or Wyoming. However, some exclusions for solar energy development exist in these states (e.g., NSO and ROW exclusions as identified in land use plans). In addition, a few of the land use plans in these states address solar energy development and have identified exclusion areas. These land use plan designations were accounted for in the calculation of lands available for and excluded from solar application under the No Action Alternative (see Table 2.1-2).

Table 2.2-4. 2012 Western Solar Plan Exclusion Criteria

2012 Western Solar Plan Exclusion Criterion	Corresponding Solar Programmatic EIS Exclusion Criterion (see Table 2.1-3)
Lands with slopes greater than 5% determined through GIS analysis using digital elevation models.	Not applicable[a]
Lands with solar insolation levels less than 6.5 kWh/m^2/day determined through National Renewable Energy Laboratory solar radiation GIS data (NREL 2023a).	Not applicable
All ACECs identified in applicable land use plans (including Desert Wildlife Management Areas in the California Desert District planning area).	1
All designated and proposed critical habitat areas for species protected under the ESA, or if critical habitat is not yet proposed, then as identified in respective recovery plans or the final listing rule (USFWS 2023b).	2
All areas for which an applicable land use plan establishes protection for lands with wilderness characteristics.	3
Developed recreational facilities, special-use permit recreation sites (e.g., ski resorts and camps), and all SRMAs identified in applicable resource management plans, except for those in the State of Nevada and a portion of the Yuma East SRMA in Arizona.	4
Sage-grouse core areas, nesting habitat, and winter habitat; Mohave ground squirrel habitat; flat-tailed horned lizard habitat; fringe-toed lizard habitat; and all other areas where the BLM has agreements with state agency partners and other entities to manage sensitive species habitat in a manner that would preclude solar energy development.	5, 6
Greater sage-grouse habitat (currently occupied, brooding, and winter habitat) as identified by the BLM in California, Nevada, and Utah; and Gunnison's sage-grouse habitat (currently occupied, brooding, and winter habitat) as identified by the BLM in Utah.	6

2012 Western Solar Plan Exclusion Criterion	Corresponding Solar Programmatic EIS Exclusion Criterion (see Table 2.1-3)
All areas designated as NSO in applicable land use plans.	7
All ROW exclusion areas identified in applicable land use plans.	7
All ROW avoidance areas identified in applicable land use plans.	7
In California, lands classified as Class C in the CDCA planning area.	Not applicable
In California and Nevada, lands in the Ivanpah Valley.	21
In Nevada, lands in Coal Valley and Garden Valley.	21
All desert tortoise translocation sites identified in applicable land use plans, project-level mitigation plans or Biological Opinions.	8
All Big Game Migratory Corridors identified in applicable land use plans.	9
All Big Game Winter Ranges identified in applicable land use plans.	9
Research Natural Areas identified in applicable land use plans.	10
Lands classified as VRM Class I or II (and, in Utah, Class III) in applicable land use plans.	11
DOI Secretary- designated National Recreation, Water, or Side and Connecting Trails and National Back Country Byways (BLM State Director approved) identified in applicable BLM and local land use plans, including any associated corridor or lands identified for protection through an applicable land use plan.	12, 13
All units of the BLM National Landscape Conservation System, congressionally designated National Scenic and Historic Trails (National Trails System Act [NTSA], P.L. 90-543, as amended), and trails recommended as suitable for designation through a congressionally authorized National Trail Feasibility Study, or such qualifying trails identified as additional routes in law (e.g., West Fork of the Old Spanish National Historic Trail), including any trail management corridors identified for protection through an applicable land use plan. Trails undergoing a congressionally authorized National Trail Feasibility Study will also be excluded pending the outcome of the study.	14
Wild, Scenic, and Recreational Rivers designated by Congress, including any associated corridor or lands identified for protection through an applicable river corridor plan.	14
Segments of rivers determined to be eligible or suitable for Wild or Scenic River status identified in applicable land use plans, including any associated corridor or lands identified for protection through an applicable land use plan.	14
National Historic and Natural Landmarks identified in applicable land use plans, including any associated lands identified for protection through an applicable land use plan.	15, 16
Lands within the boundaries of properties listed in the NRHP and any additional lands outside the designated boundaries identified for protection through an applicable land use plan.	16
TCPs and Native American sacred sites as identified through consultation with Tribes and recognized by the BLM.	17
Old Growth Forest identified in applicable land use plans.	18
Lands within a solar energy development application area found to be inappropriate for solar energy development through an environmental review process that occurred prior to finalization of the Draft Solar PEIS for the Western Solar Plan.	19
Lands previously proposed for inclusion in SEZs that were determined to be inappropriate for development through the NEPA process for the Solar PEIS (limited to parts of the Brenda SEZ in Arizona; the previously proposed Iron Mountain SEZ area and parts of the Pisgah and Riverside East SEZs in California; parts of the De Tilla Gulch, Fourmile East, and Los Mogotes East SEZs in Colorado; and parts of the Amargosa Valley SEZ in Nevada).	19
In California, all lands within the proposed Mojave Trails National Monument and all conservation lands acquired outside of the proposed Monument through donations or use of Land and Water Conservation Funds.	Not applicable
In California, BLM-administered lands proposed for transfer to the NPS with the concurrence of the BLM.	Not applicable

2012 Western Solar Plan Exclusion Criterion	Corresponding Solar Programmatic EIS Exclusion Criterion (see Table 2.1-3)
Specific areas identified since the publication of the Supplement to the Draft Solar PEIS for the Western Solar Plan by the BLM based on continued consultation with cooperating agencies and Tribes to protect sensitive natural, visual, and cultural resources (total of 1,066,497 acres [4,316 km^2]; see Figure A-1; note there are some overlapping exclusions). Data and finer scale maps will be made available at http://solareis.anl.gov. Note that in some cases, the description of these areas will be withheld from the public to ensure protection of the resource.	19

[a] A slope exclusion criterion for areas with slopes 10% or greater applies to Alternatives 2 through 5.

2.1.2.2 Design Features

The 2012 Western Solar Plan established a set of programmatic design features that are required, and would continue to be required under the No Action Alternative, for all utility-scale solar energy development on BLM-administered lands in the six-state planning area. The 2012 Western Solar Plan design features were derived from comprehensive reviews of solar energy development activities at that time, published data regarding solar energy development impacts, relevant mitigation guidance available at that time, and standard industry practices.

2.1.2.3 Variance Process

The 2012 Western Solar Plan defined variance areas as areas that may be available for utility-scale solar energy ROW application subject to special requirements or considerations. Variance areas are open to application but require developers to adhere to the variance process requirements described in Appendix B, Section B.5, of the 2012 Western Solar Plan ROD (BLM 2012a). The BLM considers ROW applications for utility-scale solar energy development in variance areas on a case-by-case basis based on environmental considerations; coordination with appropriate federal, state, and local agencies and Tribes; and public outreach. The applicant is responsible for demonstrating to the BLM and other coordinating parties that a proposal in a variance area will avoid, minimize, and/or compensate for, as necessary, impacts on sensitive resources.

The variance process is also informed by BLM Instruction Memorandum (IM) 2023-015 (BLM 2022), which calls for screening applications to prioritize technically and financially feasible proposals, followed by an evaluation of reasonably foreseeable impacts across resource areas. The NEPA process for projects proposed in variance areas only begins after these reviews have been completed and requires concurrence from the BLM Director that the project should move forward to that next step.

Under the No Action Alternative, this variance process would continue for applications in variance areas designated under the 2012 Western Solar Plan and subsequent land use planning decisions.

2.2 Reasonably Foreseeable Development Scenario (RFDS)

The BLM outlined a Reasonably Foreseeable Development Scenario (RFDS) projecting the amount of land area and electricity-generating capacity (power) needed to support potential utility-scale solar energy development in the 11-state planning area through the year 2045 to inform this Programmatic EIS. The year 2045 was used because it allows for approximately 20 years of development, which is the typical time period the BLM uses for programmatic planning. The RFDS allows the BLM to evaluate whether the amount of land available for solar application under the alternatives would be adequate to meet the nation's renewable energy goals and anticipated development.

Background and details on RFDS development are provided in Appendix C. The RFDS land use and power values presented in this section and Appendix C were used in the evaluations of the cumulative impacts of solar energy development on resources in the 11-state planning area that are presented in Chapter 5.

Table 2.2-1 presents an estimate of the amount of land required for solar energy development (the RFDS), including an estimate of the subset that would be developed on BLM-administered lands. State-level projections of solar energy development by 2045 are based on the DOE's *Solar Futures Study* (DOE 2021) and its companion report on environmental implications (NREL 2022). The BLM will continue to refine the RFDS, including in response to public comments. The Final Programmatic EIS, therefore, may include revisions to the RFDS and corresponding changes to the analysis of cumulative impacts and other aspects of the Programmatic EIS that rely on the RFDS.

As detailed in Appendix C, the analysis assumes that as much as 75% of future solar energy development would occur on BLM-administered lands versus non-BLM-administered lands. This assumption will likely overestimate the amount of utility-scale solar energy development on BLM-administered lands for some states and underestimate development for other states, but overall is likely an overestimate of lands needed.

Table 2.2-2 shows the estimated total amount of BLM-administered lands that would be available for application in each state under the Action Alternatives, compared to the RFDS estimate of the amount of BLM-administered land that will be needed for solar energy development in that state. Due to the uncertainties in estimating the state-level RFDS values, it is recommended that the total RFDS for BLM-administered lands across the 11-state planning area (697,830 acres) be used as the primary scope of comparison. Although in general the lands available in each state would adequately support estimated development under the RFDS, the state-level RFDS values are best understood as forecasted estimates that may shift among states. The BLM considers the total RFDS across the 11-state planning area to be a useful indicator that lands available for application will be adequate to support the nation's renewable energy goals over the next 20 years.

For ease of comparison and because the RFDS is an estimate, the 697,830 acres are rounded to 700,000 acres for comparisons made throughout this EIS.

Table 2.2-1. Reasonably Foreseeable Development Scenario[a]

State	Estimated Area Developed by 2045 Under RFDS (acres), by Landholding		Total State Land Area (acres)	BLM-Administered Land Area (% state total acres)
	BLM	Non-BLM		
Arizona	198,210	66,071	72,958,449	12,109,337 (17%)
California[b]	109,972	130,920	47,484,043	4,150,345 (6%)
Colorado	45,207	15,070	66,620,001	8,354,303 (13%)
Idaho	89,574	29,859	53,484,044	11,774,830 (22%)
Montana	5,387	1,797	94,105,196	8,043,026 (9%)
Nevada	48,119	16,040	70,757,520	47,272,125 (67%)
New Mexico	11,123	3,708	77,817,452	13,493,392 (17%)
Oregon	51,387	17,129	62,128,249	15,718,196 (25%)
Utah	39,793	13,264	54,334,651	22,767,896 (42%)
Washington	71,781	23,927	43,276,212	437,237 (1%)
Wyoming	27,277	9,092	62,600,125	18,047,487 (29%)
Total RFDS Acres	**697,809**	**326,877**	—	—

Sources: DOE (2021), NREL (2022).

[a] NREL (2022) estimates that a total of 1,307,493 acres of land in the 11-state planning area will be utilized for utility-scale solar energy development by 2045.

[b] The DRECP area, which accounts for 72% of BLM-administered land in California, is excluded from the scope of this Programmatic EIS. The RFDS assumes that 72% of future solar development will occur in the DRECP area, and the remaining 28% will occur on BLM-administered lands outside of the DRECP area. Thus, the RFDS estimate for non-DRECP BLM-administered lands in California is 28% of the overall projected development on BLM-administered lands in California. It is estimated that 282,786 acres of BLM-administered land within the DRECP planning area would be developed by 2045 under the RFDS, thus accounting for the total of 1,307,493 acres in the 11-state planning area.

For some resource areas, the RFDS is expressed in terms of the projected power-generating capacity (in megawatts) to estimate cumulative impacts. For example, the socioeconomic impacts in terms of jobs and income created, and the water use impacts are estimated on a per-megawatt basis. To express the RFDS in megawatts, the projected land areas given in Table 2.2-1 were assumed to correspond to land use in the range of 7–8 acres/MW (NREL 2022). The corresponding total megawatt projections range from about 87,000 to 100,000 MW of power generated on BLM-administered lands and 76,000 to 87,000 MW of power generated on non-BLM lands in the 11-state planning area.

Table 2.2-2. Available BLM-Administered Lands Developed Under the Action Alternatives Compared to the RFDS

State	RFDS, Estimated BLM Area Developed by 2045 (acres)	Areas Available for Application (acres)				
		Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Arizona	198,210	4,886,293	3,285,400	2,292,321	887,183	725,628
California	109,972	1,145,205	220,088	157,698	116,417	89,258
Colorado	45,207	2,281,931	813,551	548,225	329,854	235,270
Idaho	89,574	2,650,929	1,835,601	1,473,202	942,187	866,830
Montana	5,387	1,229,774	715,863	209,796	513,232	149,389
Nevada	48,119	18,332,220	12,371,628	6,988,748	2,424,286	1,587,446
New Mexico	11,123	6,301,088	5,000,154	2,987,559	1,765,014	1,301,315
Oregon	51,387	2,553,861	1,125,451	714,957	408,071	308,340
Utah	39,793	9,883,743	6,562,857	3,768,382	1,938,117	1,570,779
Washington	71,781	355,229	125,134	106,458	94,975	81,211
Wyoming	27,255	5,417,541	4,124,996	2,980,130	1,779,148	1,444,249
Total	**697,809**	**55,037,816**	**36,180,723**	**22,227,475**	**11,198,484**	**8,359,715**

2.3 Alternatives Considered but Not Analyzed in Detail

2.3.1 Use of Solar Insolation Exclusion

The 2012 Western Solar Plan excludes solar energy development where insolation values are below 6.5 kWh/m^2, on the basis of “the assumption that at insolation levels below 6.5 kWh/m^2/day, utility-scale development would be less economically viable given current technologies” (BLM and DOE 2012). The restriction was intended to maximize the efficient use of BLM-administered lands and further FLPMA’s multiple use mandate by reserving for other uses lands that are not well suited for solar energy development. It was not based on concerns regarding adverse impacts on resources.

The technological constraints on development in areas of low solar insolation that were present in 2012 no longer exist. Due to technological advances and reduced costs in PV systems in the approximately ten years since the Western Solar Plan was issued, the BLM has received continued interest from PV solar developers in locations that were allocated as exclusion areas under the Western Solar Plan on the basis of low solar insolation. Therefore, under each of the Action Alternatives in this Solar Programmatic

EIS, the solar insolation technology-based exclusion criterion is not applied, although it would persist as an aspect of the status quo under the No Action Alternative.

2.3.2 Identification of New SEZs

The Western Solar Plan emphasized and incentivized development within priority areas (i.e., SEZs) and included a collaborative process to identify additional SEZs.[8] The BLM's goal in prioritizing and incentivizing development in SEZs was to direct development of solar energy projects to locations on BLM-administered lands with high potential for solar energy generation and low potential for resource conflicts. However, the analysis and designation of these priority areas did not entirely meet the goal of directing development to these areas; since 2012, the BLM has received and approved the same number of utility-scale solar energy development applications in areas identified as variance areas as it has within priority areas (see Table 2.3-1). During the scoping process for this Programmatic EIS, many commenters recommended that priority areas be located in low-conflict areas that are near transmission infrastructure or on disturbed/degraded lands. They noted that the suitability of many SEZs from the 2012 Western Solar Plan was limited by poor access to transmission infrastructure and substations.

Table 2.3-1. Number and Size of Solar Projects Approved on BLM-Administered Land Since 2012, by SEZ and Variance Areas

State	Number of Projects	Total Acres	SEZs/Priority Areas		Variance Areas	
			Number of Projects	Acres	Number of Projects	Acres
Arizona	6	9,035	2	5,601	4	3,434
California	14	25,288	9	16,283	5	9,005
New Mexico	2	14	0	0	2	14
Nevada	10	17,078	5	3,182	5	13,896
Utah	1	4,836	1	4,836	0	0
Wyoming	1	584	0	0	1	584
Total	**34**	**56,835**	**17**	**29,902**	**17**	**26,933**

Therefore, under this Programmatic EIS, none of the Action Alternatives include a process for identifying or analyzing new SEZs. Instead, the various Action Alternatives in this Programmatic EIS identify lands available for application. The suitability for any particular solar energy development ROW application would be evaluated using site- and project-specific analysis, tiering to this Programmatic EIS as appropriate.

The SEZs and other priority areas identified in the 2012 Western Solar Plan and through subsequent processes have recently seen increased development interest, and in

[8] Additional priority areas/SEZs that were designated in land use plans since 2012 include the Agua Caliente SEZ in Arizona, REDAs in Arizona, the West Chocolate Mountains SEZ within the California DRECP planning area, two solar emphasis areas in Colorado, and the Dry Lake East DLA in Nevada. (DLA is a term used for priority solar energy development areas in the BLM's 2017 solar and wind energy development regulations, 81 FR 92122). The former Fourmile East SEZ in Colorado was un-designated in 2018; this Solar Programmatic EIS proposes un-designating the Los Mogotes SEZ in Colorado due to Tribal concerns, as well as the REDAs in Arizona.

general would be retained as available for application under the Action Alternatives in this Solar Programmatic EIS, with minor adjustments to account for the new and revised exclusion criteria. Under the Action Alternatives, the Los Mogotes SEZ and the REDA priority area designations would be removed.

2.3.3 Identification of Variance Areas

The Western Solar Plan defined a variance area as an area that may be available for a utility-scale solar energy ROW subject to special stipulations or considerations. For ROW applications in variance areas, developers must adhere to the variance process requirements described in Appendix B, Section B.5, of the 2012 Western Solar Plan ROD (BLM 2012a). The requirements include a review of all variance area applications by the BLM Director. If approved, applications then proceed to evaluation and NEPA analysis.

In the Notice of Intent (NOI) for this Programmatic EIS (87 FR 75284), the BLM explained that:

> *"[t]he variance process has been in place for over a decade and was intended to support preliminary screening of applications as a means to validate the technical and financial feasibility of proposed solar projects, gauge the potential for conflicts with key resources and other existing uses using available information, and help ensure that certain up-front coordination has commenced with appropriate State and local governments before committing significant agency resources for a project-specific NEPA analysis."*

In the NOI the BLM indicated that it would:

> *"consider modifications to the variance process to focus the review and improve efficiency" [and] "whether the process should be included in the Programmatic EIS or whether the variance procedures would more appropriately be effectuated by other means, such as through regulation or policy."*

The BLM has found the designation of variance areas and the variance process under the 2012 Western Solar Plan to be useful, particularly coupled with the identification of smaller, discrete, SEZs. Since 2012, the BLM has approved the same number of projects in variance lands as in SEZs (Table 2.3-1). However, the BLM has elected not to incorporate the identification of variance lands into the framework of this Programmatic EIS. Under all Action Alternatives, BLM-administered lands are identified as either available or excluded from solar energy application. Development in areas identified as excluded from application would require a land use plan amendment. The rationale for this change is that the variance process has proved to be time-consuming and repetitive of the project-specific NEPA review that is required for all solar energy development projects on BLM-administered lands. In addition, as proposed in this Programmatic EIS, the required screening of project applications including review of the application area for intersections with areas of special concern (as listed in Appendix H) largely fulfills the goals of the variance process. Eliminating the identification of variance lands and the variance process is consistent with public comments across a wide array of stakeholders (conservation nongovernmental organizations, counties, and developers). The existing designations of variance lands and requirements of the variance process would persist as aspects of the status quo under the No Action Alternative.

2.3.4 Restricting Development to Previously Contaminated Lands

Many comments were received during the scoping process for this Programmatic EIS requesting that the BLM consider siting utility-scale solar projects only on previously contaminated lands (BLM 2023d). The BLM investigated the feasibility of this restriction by evaluating the extent of BLM-administered lands in the 11-state planning area that intersect with lands in the EPA's Re-Powering America database (which includes current and formerly contaminated lands, landfills, and mine sites; EPA 2023a). The extent of intersection was quite small: only 30 contaminated sites encompassing approximately 1,785 acres were located on BLM-administered lands in the 11-state planning area. Given the estimated need under the RFDS for approximately 700,000 acres for utility-scale solar energy development over the next 20 years (Section 2.2), limiting development on BLM-administered lands to contaminated lands would not allow the BLM to meet the purpose and need described in Section 1.1 of this Programmatic EIS. Therefore, the BLM used an alternative approach as part of Alternatives 4 and 5 that evaluates limiting development to previously disturbed lands.

2.3.5 Consideration of Distributed Generation, Energy Conservation, and Private Lands Alternative

The BLM received a number of scoping comments requesting analysis of distributed generation (small-scale [<10 MW] solar energy facilities located at homes or businesses), energy conservation (reducing energy consumption levels in order to reduce the need for increased electricity generation capacity), and development only on private lands.

Distributed solar energy generation alone cannot meet the goals for renewable energy development, and development of both distributed generation and utility-scale solar power, deployed at increased levels, will be needed to meet future energy needs in the United States, along with other energy resources and energy efficiency technologies (DOE 2021). For example, in 2045 under a decarbonized grid scenario with high electrification, an estimated 40% of power would need to be generated from solar energy sources, and about 90% of that generation would need to come from utility-scale solar energy development, with the remaining 10% to come from distributed sources (DOE 2021).

Energy conservation initiatives are designed to reduce energy consumption levels in order to reduce the need for increased electricity generation capacity. This involves specific actions taken by utilities, their regulators, and other entities to induce, influence, or compel consumers to reduce their energy consumption, particularly during periods of peak demand. The BLM has no authority or influence over the implementation of energy conservation practices.

Solar energy development on private lands is occurring throughout the United States. As discussed in Section 2.2., estimates of the amount of development that will occur on private versus BLM-administered lands in the 11-state planning area are uncertain at this time. The BLM does not have authority over solar energy development on private lands.

Alternatives incorporating or relying exclusively at distributed generation, energy conservation, and development only on private lands do not respond to the BLM's purpose and need for agency action in this Programmatic EIS. The BLM's purpose and need are derived from the Energy Act of 2020, which instructs the BLM to seek to issue permits authorizing production of not less than 25 GW of electricity from renewable sources by 2025, and E.O. 14008 (86 FR 7619), which ordered the BLM to review renewable energy siting and permitting processes on public lands. To address those obligations, the BLM's consideration of alternatives in this Solar Programmatic EIS is focused on the identification of BLM-administered lands suitable for utility-scale solar energy development.

2.3.6 Western Alliance "Smart from the Start" Alternative

A number of cooperating agencies collectively proposed an alternative that would make lands available for solar energy development application that are within 10 miles of existing or authorized transmission lines and constitute both "disturbed lands" and "low conflict lands", as the proposed alternative defines those terms.

The proposed alternative would define "disturbed lands" as:

1. Lands verified as having heavy anthropogenic disturbance (such as abandoned or reclaimed mining sites or lands that have been identified by a state or local land use plan as brownfields for redevelopment) or
2. Lands verified as having greater than 40% invasive annuals and on which the ecological site description (ESD) and associated state and transition model (STM)/disturbance response group do not have a restoration pathway back to non-invasive vegetative communities.

The proposed alternative would define "low conflict lands" as lands that:

1. Are neither in "core" nor "growth" sagebrush areas (according to the USFWS Sagebrush Conservation Design),
2. Are set back by at least a mile-wide buffer zone from agricultural uses, homes, source water protection areas, important wildlife habitat (e.g. greater sage-grouse priority and general habitat areas), and cultural or historical resources,
3. Do not include lands identified in an applicable RMP as suitable for disposal if disposal criteria include meeting local public purposes (including community expansion, recreation, and economic development),
4. Do not include important habitat connectivity zones or migration corridors,

5. Either do not have valid preexisting rights, permitted uses, or public access routes, or, if these are present, impacts to them are minimized and mitigated, and;
6. Are identified through consultation and coordination with relevant local and state government agencies as being appropriate for utility scale renewable energy development.

The BLM has decided not to carry this alternative forward for detailed analysis. The proposed “disturbed lands” criteria are substantially similar to those already included in Alternatives 4 and 5. The “low conflict lands” criteria are either already included in the exclusion criteria described in Table 2.1-3 or would more appropriately be addressed during project-specific reviews. As discussed in Section 1.1.7 of this Programmatic EIS, the goal of this programmatic effort is to identify appropriate categories of lands that are, as a general proposition, suitable for utility-scale solar development, including because the BLM would expect fewer conflicts with resources and other land uses in those areas. This programmatic effort does not, and cannot, determine the suitability in fact of all potential sites within those categories. Prior to making any decision regarding a specific project ROW application, the BLM will review the application to determine the suitability of the proposed project. Project-specific reviews will include, as appropriate, evaluation of the area proposed for application, including a review of consistency with the applicable land use plan and consideration of potential resource-related conflicts, effects on other land uses, proximity to important resources, and other public concerns.

2.4 Summary Comparison of Alternatives

The comparison of impacts between alternatives described in Table 2.4-1 is based on the detailed discussion of the affected environment and impacts of solar energy development provided in Chapters 4 and 5 of this Programmatic EIS. Many of the impacts of utility-scale solar energy development are similar across the alternatives. However, the varying allocation and exclusion criteria across the alternatives results in different amounts of land available for application and different locations of development.

Table 2.4-1. Comparison of Impacts Between Alternatives for Utility-Scale Solar Energy Development on BLM-Administered Lands

Resource	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Acoustic Environment (Section 5.1)	Common impacts: Noise impacts may come from equipment used for land clearing, grading, site preparation, and construction, with the highest noise levels occurring during site preparation. Construction-related noise may adversely affect nearby residents and/or wildlife. Operations-related noise impacts would be less than construction-related impacts. Impacts from development to the RFDS level are expected to be low and similar under all alternatives.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis.[a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.1) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
Air Quality (Section 5.2.1)	Common impacts: Air quality would be adversely affected locally and temporarily during construction by fugitive dust and vehicle emissions, although impacts would be relatively minor. Operations would generally result in few air quality impacts, though for larger facilities with erodible soil and where vegetation has been removed fugitive dust emissions may cause substantial impacts.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis.[a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.2) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
		Impacts from development to the RFDS level are expected to be similar under Alternatives 1 and 2.		Because lands available for application under Alternatives 3, 4 and 5 are restricted to areas that are close to existing or planned transmission and/or have been previously disturbed, those areas may be more distant from Federal Class I or other specially designated areas, and thus impacts may be reduced under these alternatives.		
Climate Change (Section 5.2.2)	Because greenhouse gas (GHG) emissions are aggregated across the global atmosphere and cumulatively contribute to climate change, climate change impacts are not particularly sensitive to the specific locations of GHG emissions within the lands available for application. Instead, the total level of solar energy development determines the GHG emissions caused and avoided. Very low GHG emissions are expected from solar energy development, most are associated with construction (particularly the use of heavy equipment and large on-road vehicles powered by diesel), along with a small contribution from small on-road vehicles powered by gasoline throughout the project. Positive impacts may occur if the generated solar energy replaces existing fossil fuel sources of energy, thus avoiding the GHG emissions from those fossil fuel sources. The emissions avoided if development reaches the RFDS level and the energy generated displaces fossil-fuel energy sources could be up to 123 million MT CO_2e/year, which represents about 51% of the 2021 annual GHG emissions from the electric power system in the 11-state planning area.					
Cultural Resources (Section 5.3)	Common impacts: Cultural resources are subject to loss during site preparation and construction, with potential impacts also possible during operations. Impacts could occur from clearing, grading, or excavation; alteration of topography or hydrologic patterns; erosion of soils; runoff and sedimentation; and/or contaminant spills. Additionally, increases in human access and associated disturbance would result from the establishment of facilities in otherwise intact and inaccessible areas. Visual and auditory degradation of settings associated with cultural resources could result from solar energy development and ancillary facilities. If a cultural resource is damaged or destroyed during development, that particular cultural location, resource, or object would be irretrievable. ACECs designated for cultural or historic resource values, National Historic and Scenic Trails, National Historic and Natural Landmarks are excluded from solar energy development, limiting direct impacts to cultural resources in these areas.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis.[a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.3) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
	A total of 103,519 known cultural resources are located on lands available for application.	A total of 120,337 known cultural resources are located on lands available for application.	A total of 86,637 known cultural resources are located on lands available for application.	A total of 63,023 known cultural resources are located on lands available for application.	A total of 51,596 known cultural resources are located on lands available for application.	A total of 41,029 known cultural resources are located on lands available for application.
Vegetation (Section 5.4.1)	Common impacts: Ground disturbance during construction may make vegetation communities more susceptible to noxious weed or invasive plant establishment. Construction also requires removal of vegetation from part or most of the solar facility area, which could result in substantial direct impacts in terms of increased risk of invasive species introduction; changes in species composition and distribution; habitat loss (e.g., dune or riparian areas); and damage to biological soil crusts. Indirect impacts include potential changes to the vegetation community with the formation of microclimates under the solar arrays, including changes in precipitation and shading.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis.[a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.4) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
	Primary ecoregions within the No Action Alternative area include the Northern Basin and Range and the Chihuahuan Desert.	Primary ecoregions within the Alternative 1 area include the Central Basin and Range and Chihuahuan Desert. The ecoregions with the greatest percentages of available lands are the Central Basin and Range (43%), the Wyoming Basin (9%), and the Colorado Plateau (7%)	Primary ecoregions within the Alternative 2 area include the Central Basin and Range and Chihuahuan Desert. The ecoregions with the greatest percentages of available lands are the Central Basin and Range (46%), the Wyoming Basin (10%), and the Chihuahuan Desert (9%).	Primary ecoregions within the Alternative 3 area include the Chihuahuan Desert and Central Basin and Range. The ecoregions with the greatest percentages of available lands are the Central Basin and Range (40%), the Wyoming Basin (12%), and the Chihuahuan Desert (10%).	Primary ecoregions within the Alternative 4 area include the Chihuahuan Desert and Snake River Plain. The ecoregions with the greatest percentages of available lands are the Central Basin and Range (31%), the Wyoming Basin (14%), and the Chihuahuan Desert (12%).	Primary ecoregions within the Alternative 5 area include the Chihuahuan Desert and Snake River Plain. The ecoregions with the greatest percentages of available lands are the Central Basin and Range (29%), the Wyoming Basin (15%), and the Chihuahuan Desert (12%)
Aquatic Biota (Section 5.4.2)	Common impacts: Depending on the location of the project, numerous aquatic species may be adversely impacted during construction, operations, and decommissioning by factors such as alteration of topography and drainage patterns, human presence, access, and activity, blockage of dispersal and movement, erosion, fugitive dust, groundwater withdrawal, habitat fragmentation, contaminant spills, vegetation clearing, and traffic. Ground disturbance associated with site characterization and construction activities can lead to increases in soil erosion that can increase sedimentation and turbidity in downgradient surface water habitats, and can lead to impacts on riparian and wetland habitats.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.4) may reduce the magnitude of impacts in comparison with the No Action Alternative.				

Resource	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
	remaining five states, mitigation is established on a project-specific basis.[a]	Impacts from development to the RFDS level are expected to be similar under Alternatives 1, 2, and 3.			Alternatives 4 and 5 potentially avoid higher quality aquatic biota habitat by focusing future development on previously disturbed lands.	
Wildlife (Section 5.4.3)	Common impacts: Numerous wildlife species may be adversely impacted by solar energy development causing loss of habitat; disturbance; loss of food and prey species; loss of breeding areas; impacts on movement and migration; introduction of new species; habitat fragmentation; and changes in water availability. Construction and operation of transmission lines and/or meteorological towers can result in bird and bat mortality. The magnitude of impacts depends on the type, amount, and location of wildlife habitat that would be disturbed, the nature of the disturbance, the wildlife that occupy the area prior to construction, and the timing of construction activities relative to the crucial life stages of wildlife.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis.[a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.4) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
	10,993 acres (0.04%) of big game migration corridor[b] would overlap with priority areas and approximately 4.7 million acres (17.3%) of big game migration corridor would overlap with other lands available for application (including variance areas in six states under 2012 Western Solar Plan). 14,638 acres (0.03%) of big game winter habitat would overlap with priority areas and approximately 15 million acres (29%) would overlap other lands available for application (including variance areas in six states under 2012 Western Solar Plan).	Approximately 6.3 million acres (23%) of big game migration corridor would overlap with lands available for application. Approximately 12.8 million acres (24%) of big game winter habitat would overlap with lands available for application.	Approximately 3.1 million acres (11%) of big game migration corridor would overlap with lands available for application. Approximately 6.2 million acres (12%) of big game winter habitat would overlap with lands available for application.	Approximately 1.8 million acres (7%) of big game migration corridor would overlap with lands available application. Approximately 4 million acres (8%) of big game winter habitat would overlap with lands available for application. Keeping development in areas that are less than 10 miles from existing and planned transmission lines would limit development to wildlife habitat that may already be impacted by edge effects of transmission infrastructure.	Approximately 1 million acres (4%) of big game migration corridor would overlap with lands available for application. Approximately 2.4 million acres (5%) of big game winter habitat would overlap with lands available for application. Limiting development to previously disturbed lands potentially avoids higher quality habitat.	Approximately 730,000 acres (3%) of big game migration corridor would overlap with lands available for application. Approximately 1.8 million acres (3%) of big game winter habitat would overlap with lands available for application. Limiting development to previously disturbed lands and to areas that are less than 10 miles from existing or planned transmission potentially avoids higher quality wildlife habitat.
	Lands available for application in the five states not included in the 2012 Western Solar Plan are not constrained by slope. Thus, development in those states could occur on sloped land resulting in increased wildlife impacts.	Lands available for application would not be limited by slope. Thus, development could occur on sloped land resulting in increased wildlife impacts.	Changing the slope exclusion criterion from 5% to 10% slope could result in greater wildlife impacts for Alternatives 2-5 in comparison with the No Action Alternative for the six states under the 2012 Western Solar Plan.			
Special Status Species (Section 5.4.4)	Common impacts: Impacts would be similar to or the same as those for vegetation, wildlife, and aquatic biota (loss of habitat; disturbance; loss of food and prey species; loss of breeding areas; impacts on movement and migration; introduction of new species; habitat fragmentation; and changes in water availability). However, because of their small population sizes and often specialized habitat needs or dependence on rare habitats, special status species may be more vulnerable to impacts than common and widespread species. Small population size makes them more vulnerable to the effects of habitat fragmentation, habitat alteration, habitat degradation, human disturbance and harassment, mortality of individuals, and the loss of genetic diversity. Tables 5.4.4-1 to 5.4.4-3 quantify the numbers of special status species present in the 11-state planning area along with the numbers potentially affected by alternative.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis.[a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.4) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
	The priority areas available overlap with habitats of 48 ESA-listed species (11% of all ESA-listed species in the planning area). The other lands available (including variance areas in six states under 2012 Western Solar Plan) overlap with 408 ESA listed species (96% of all ESA listed species in the planning area). The lands available also overlap with high numbers of BLM-sensitive and State-listed species.	The lands available for application overlap with habitats of 375 ES-listed species (88% of all ESA-listed species in the planning area), along with high numbers of BLM-sensitive and State-listed species. This represents the greatest potential impact on special status species as compared to the other Action Alternatives.	The lands available for application overlap with habitats of 312 ESA-listed species (73% of all ESA-listed species in the planning area), along with high numbers of BLM-sensitive and State-listed species.	The lands available for application overlap with habitats of 300 ESA-listed species (71% of all ESA-listed species in the planning area), along with high numbers of BLM-sensitive and State-listed species.	The lands available for application overlap with habitats of 297 ESA-listed species (70% of all ESA-listed species in the planning area), along with high numbers of BLM-sensitive and State-listed species.	The lands available for application overlap with habitats of 287 ESA-listed species (68% of all ESA-listed species in the planning area), along with high numbers of BLM-sensitive and State-listed species. This represents the least potential impact on special status species as compared to the other action alternatives.
Environmental Justice (EJ) (Section 5.5)	Common impacts: Solar energy development has potential for EJ impacts where minority or low-income populations may be affected. Such impacts may derive from air pollution, noise, land use, cultural, or socioeconomic impacts. These impacts may be negative, as in the case of increased noise levels or altered land use patterns, or positive, as in the case of local or regional economic benefits resulting from increased jobs and revenue, and the potential displacement of as much as 123 million MT/year CO_2.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.5) may reduce the magnitude of impacts in comparison with the No Action Alternative.				

Resource	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
	remaining five states, mitigation is established on a project-specific basis.[a]					
	The no action alternative area contains minority and/or low-income populations, including approximately 1.9 million individuals in low-income areas and approximately 900,000 individuals in minority areas.	The Alternative 1 area contains minority and/or low-income populations, including approximately 1.4 million individuals in low-income areas and approximately 580,000 individuals in minority areas.	The Alternative 2 area contains minority and/or low-income populations, including approximately 960,000 individuals in low-income areas and approximately 450,000 individuals in minority areas.	The Alternative 3 area contains minority and/or low-income populations, including approximately 900,000 individuals in low-income areas and 425,000 individuals in minority areas.	The Alternative 4 area contains minority and/or low-income populations, including approximately 900,000 individuals in low-income areas and approximately 400,000 individuals in minority areas.	The Alternative 5 area contains minority and/or low-income populations, including approximately 850,000 individuals in low-income areas and 400,000 individuals in minority areas.
Geology and Soil Resources (Section 5.6)	Common impacts: Development of large blocks of land for solar energy facilities and related infrastructure could result in substantial impacts to geologic and soil resources, potentially including farmland. Common impacts include soil compaction; soil horizon mixing; soil erosion and deposition by wind; soil erosion by water and surface runoff; sedimentation; and soil contamination.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis.[a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.6) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
	Development on slopes greater than 5% is excluded, (for the six states under the 2012 Western Solar Plan) decreasing the potential for erosion of disturbed soils. Lack of any slope exclusion in the five states not addressed under the 2012 Western Solar Plan increases the potential for erosion of disturbed soils in comparison with the six states under the Western Solar Plan.	Lack of any slope exclusion would increase the potential for erosion of disturbed soils, as compared to the six states under the Western Solar Plan in the No Action Alternative and the other Action Alternatives.	Development on slopes greater than 10% would be excluded, reducing the potential for erosion of disturbed soils as compared to Alternative 1. The potential for soil erosion would increase in the six states under the 2012 Western Solar Plan, as compared to the No Action Alternative, because BLM-administered lands with a slope between 5 and 10% would be available for solar energy development.	As under Alternative 2, development on slopes greater than 10% would be excluded, reducing the potential for erosion of disturbed soils as compared to Alternative 1.Soil disturbance associated with transmission line development would potentially be reduced as compared to Alternatives 1 and 2 if fewer miles of transmission line development would occur due to the exclusion of lands greater than 10 miles from existing and planned transmission lines.	Development on slopes greater than 10% would be excluded, reducing the potential for erosion of disturbed soils similar to Alternatives 2 and 3.	Development on slopes greater than 10% would be excluded, reducing the potential for erosion of disturbed soils similar to Alternatives 2-4. Soil disturbance associated with transmission line development would potentially be reduced as compared to Alternatives 1, 2, and 4, if fewer miles of transmission line development would occur due to the exclusion of lands greater than 10 miles from existing and planned transmission lines.
	Approximately 8.4 million acres (17.7%) of available lands have a farmland classification. The projected area of development under the RFDS is about 1.4% of the available lands without farmland classification.	Approximately 5.2 million acres (9.4%) of available lands have a farmland classification. The projected area of development under the RFDS is about 1.4% of the available lands without farmland classification.	Approximately 4.6 million acres (12.7%) of available lands have a farmland classification. The projected area of development under the RFDS is about 2.2% of the available lands without farmland classification. This alternative could increase impacts to productive or potentially productive farmland compared to Alternative 1.	Approximately 2.8 million acres (12.5%) of available lands have a farmland classification. The projected area of development under the RFDS is about 3.6% of the available lands without farmland classification. This alternative could increase impacts to productive or potentially productive farmland compared to Alternatives 1 and 2.	Approximately 2 million acres (17.6%) of available lands have a farmland classification. The projected area of development under the RFDS is about 7.6% of the available lands without farmland classification. This alternative could increase impacts to productive or potentially productive farmland compared to Alternatives 1 through 3.	Approximately 1.4 million acres (16.3%) of available lands have a farmland classification. The projected area of development under the RFDS is about 10% of the available lands without farmland classification. This alternative could increase impacts to productive or potentially productive farmland compared to Alternatives 1 through 4.
Hazardous Materials and Waste (Section 5.7)	Common impacts: Impacts from the hazardous materials present during construction include increased risks of fires and contamination of environmental media from improper storage and handling, leading to spills or leaks. Impacts from development to the RFDS level are expected to be similar under all alternatives.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.7) may reduce the magnitude of impacts in comparison with the No Action Alternative.				

Resource	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Health and Safety (Section 5.8)	Common impacts: Impacts on health and safety from the development of solar energy facilities include occupational health and safety impacts (physical hazards, risks resulting from exposure to weather extremes, retinal exposures to high levels of glare, dust from construction activities, electrical shock, and exposures to hazardous substances, fire hazards, and the possibility of increased cancer risk if exposure to magnetic fields); public health and safety (physical hazards from unauthorized access, increased risk of traffic accidents, risk from public exposure to hazardous substances, and electrical hazards); natural events, and sabotage or terrorism. Impacts from development to the RFDS level are expected to be similar under all alternatives.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.8) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
Lands and Realty (Section 5.9)	Common impacts: Utility-scale solar energy development generally precludes other land uses within the project footprint and alters the character of largely open and undeveloped areas. Development of supporting infrastructure (e.g., new transmission lines, roads) also impacts local land use in the vicinity of the solar facility. Development has potential to fragment blocks of public land, creating isolated public land parcels which can be difficult to manage.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.9) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
		Impacts from development to the RFDS level are expected to be similar under Alternatives 1, 2, and 4.		Limiting development to within 10 miles of transmission lines may reduce impacts on land use by limiting the number and distance of any new transmission lines and ROWs.	Impacts from development to the RFDS level are expected to be similar under Alternatives 1, 2, and 4.	Limiting development to within 10 miles of transmission lines may reduce impacts on land use by limiting the number and distance of any new transmission lines and ROWs.
Military and Civilian Aviation (Section 5.10)	Common impacts: Impacts on aviation could occur if structures or equipment were positioned such that it would be a hazard to navigable airspace. Potential impacts could include safety concerns such as glare (reflectivity), radar interference, and physical penetration of airspace. Impacts from development to the RFDS level are expected to be similar under all alternatives.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.10) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
Minerals (Section 5.11)	Common impacts: Mining and extraction activities are affected by solar energy development ROW authorizations through reductions in acreage typically available for mineral extraction. Mineral development within the project ROW is generally an incompatible use; however, some resources underlying the project areas might be developable (e.g., through use of directional/horizontal drilling for oil and gas or geothermal resources, or underground mining). Lands within SEZs are withdrawn from location and entry under the mining laws. Lands within SEZs remain withdrawn from locatable mineral entry under the mining laws until 2032. (NOTE: In general, SEZ designations would remain unchanged under Alternatives 1-5, except that the Los Mogotes SEZ would no longer be a designated priority area.)					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.11) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
		Impacts from development to the RFDS level are expected to be similar under Alternatives 1, 2, and 3.			The restriction to use of disturbed lands could drive development to areas where more mineral operations leases already exist, making obtaining ROWs more difficult under Alternatives 4 and 5.	
Paleontological Resources (Section 5.12.1)	Common impacts: Paleontological resources can be adversely impacted by solar energy development ROW authorizations through degradation or destruction of the resource, loss of valuable scientific information, and increased human access and disturbance associated with clearing, grading, and excavation of project areas.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.12) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
	42,140 acres within priority areas are located within Potential Fossil Yield Classification (PFYC) Class 4 or 5; approximately 11.2 million acres of lands available for application (including variance areas in six states under 2012 Western Solar Plan) would be located within PFYC Class 4 (high) or 5 (very high), which represents 24% of the total lands available for application.	Approximately 10.2 million acres of land within areas available for application would be located within PFYC Class 4 or 5, which represents 19% of the total lands available for application.	Approximately 5.7 million acres of land within areas available for application would be located within PFYC Class 4 or 5, which represents 16% of the total lands available for application.	Approximately 4 million acres of land within areas available for application would be located within PFYC Class 4 or 5, which represents 18% of the total lands available for application.	Approximately 2.2 million acres of land within areas available for application would be located within PFYC Class 4 or 5, which represents 20% of the total lands available for application.	Approximately 1.7 million acres of land within areas available for application would be located within PFYC Class 4 or 5, which represents 20% of the total lands available for application.
	Common impacts: Until such time that cattle grazing under solar panels becomes feasible, grazing activities would likely be excluded from areas developed for utility-scale solar energy production. Livestock grazing allotments are affected by solar energy development ROW authorizations through reductions in acreage and/or loss of animal unit months (AUMs).					

Resource	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Livestock Grazing (Section 5.13.1)	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.13) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
	Approximately 310,000 acres of grazing allotments are located within priority areas; approximately 42.8 million acres of grazing allotments are located in lands available for application (including variance areas in the six states under the 2012 Western Solar Plan).	Approximately 50.3 million acres of grazing allotments would be located within lands available for application, which represents 91% of the total lands available for application. Assuming development projected under the RFDS is evenly distributed within/outside of current grazing allotments, development is expected on approximately 1% of the total available grazing allotment area.	Approximately 32.2 million acres of grazing allotments would be located within lands available for application, which represents 89% of the total lands available for application. Assuming development projected under the RFDS is evenly distributed within/outside of current grazing allotments, development is expected on approximately 2% of the total available grazing allotment area.	Approximately 19.4 million acres of grazing allotments would be located within lands available for application, which represents 88% of the total lands available for application. Assuming development projected under the RFDS is evenly distributed within/outside of current grazing allotments, development is expected on approximately 3% of the total available grazing allotment area.	Approximately 9.9 million acres of grazing allotments would be located within lands available for application, which represents 88% of the total lands available for application. Assuming development projected under the RFDS is evenly distributed within/outside of current grazing allotments, development is expected on approximately 5% of the total available grazing allotment area.	Approximately 7.3 million acres of grazing allotments would be located within lands available for application, which represents 86% of the total lands available for application. Assuming development projected under the RFDS is evenly distributed within/outside of current grazing allotments, development is expected on approximately 7% of the total available grazing allotment area.
Wild Horses and Burros (WH&Bs) (Section 5.13.2)	Common impacts: Solar energy development may affect WH&B resource features (i.e., forage, water, cover, and space), individuals and populations, the continuance of a thriving natural ecological balance, and could result in reduction in herd management area (HMA) acreage, or affect the appropriate management level (AML) of a HMA.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.13) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
	106 acres of HMAs are located within priority areas, and approximately 5.6 million acres of HMAs are located within other lands available for application (including variance areas for six states under the 2012 Western Solar Plan), which represents approximately 22% of public land available for application.	Approximately 8.9 million acres of HMAs would be located within lands available for application, which represents 16% of the total land available for application.	Approximately 5 million acres of HMAs would be located within lands available for application, which represents 14% of the total land available for application.	Approximately 2.4 million acres of HMAs would be located within lands available for application, which represents 11% of the total land available for application.	Approximately 870,000 acres of HMAs would be located within lands available for application, which represents 8% of the total land available for application.	Approximately 500,000 acres of HMAs would be located within lands available for application, which represents 6% of the total land available for application. Because the development
Recreation (Section 5.14)	Common impacts: Recreational use would be excluded from all areas developed for solar energy facilities, including areas currently designated for OHV use. There may also be adverse impacts on recreational use of lands located nearby, including lands not administered by the BLM. Indirect impacts on recreational use would occur primarily on lands near the solar energy facilities and would result from the change in the overall character of undeveloped lands to an industrialized, developed area that would displace people who are seeking more rural or primitive surroundings for recreation. Changes to the visual landscape, impacts on vegetation, development of roads, and displacement of wildlife species resulting in reduction in recreational opportunities could degrade the recreational experience near where solar energy development occurs.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.14) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
	All SRMAs in the six states in the Western Solar Plan are excluded, except SRMAs in Nevada, which are available for application unless otherwise excluded. SRMAs in five states are not excluded.	All SRMAs in the 11-state planning area would be excluded from development. This could potentially reduce recreational impacts in comparison to the No Action Alternative.				
	Within five states not addressed in the 2012 Western Solar Plan, all lands would be available for application, after application of any exclusions specified in applicable land use plans. Recreational use would be excluded from all developed areas.	Impacts from development to the RFDS level are expected to be similar under Alternatives 1 and 2.		Limiting development to within 10 miles of transmission lines could reduce recreation impacts compared to Alternatives 1, 2, and 4, because generally shorter transmission lines would minimize adverse impacts to the recreational experience.	Limiting development to previously disturbed lands could result in avoiding intact areas where people recreate, in comparison with Alternatives 1-3.	Limiting development to within 10 miles of transmission lines could reduce recreation impacts compared to Alternatives 1, 2, and 4, because generally shorter transmission lines would minimize adverse impacts to the recreational experience. Limiting development to previously disturbed lands could result in avoiding intact areas where people recreate, in comparison with Alternatives 1-3.

Resource	No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Socioeconomics (Section 5.15)	Common impacts: Construction and operation of PV facilities could impact job creation, income, state tax income, in-migration, and government service costs. Impacts from development to the RFDS level are expected to be similar under all alternatives though the distribution of these impacts will be more concentrated in some alternatives.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.15) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
Specially Designated Areas and Lands with Wilderness Characteristics (Section 5.16)	Common impacts: Specially designated lands and lands with wilderness characteristics (LWCs) protected in applicable land use plans may be indirectly impacted (e.g., visual impacts, reduced access, and fugitive dust) during both the construction and operations phases.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.16) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
	Specially designated lands and lands with wilderness characteristics (as described under the Action Alternatives) are excluded from application in the six states addressed in the Western Solar Plan.	NCLs are excluded from application, along with ACECs; Desert Wildlife Management Areas; National Recreation Trails and National Back Country Byways; Wild, Scenic, and Recreational Rivers, and segments of rivers determined to be eligible or suitable for Wild and Scenic River status. All areas where there is an applicable land use plan decision to protect LWCs are excluded.				
		Impacts from development to the RFDS level are expected to be similar under Alternatives 1-5. Specially designated areas are excluded from solar energy development, but such areas near solar energy facilities could be adversely impacted. Impacts would depend on the characteristics of the solar energy facility and the proximity to specially designated areas.				
Transportation (Section 5.17)	Common impacts: Local road systems and traffic flow may be adversely impacted during construction for some projects. Impacts during operations are expected to be minor.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.17) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
		Impacts from development to the RFDS level are expected to be similar under Alternatives 1 and 2.		Limiting development to areas within 10 miles of existing and planned transmission lines could limit traffic and road impacts to areas near existing roadways and access roads that have been developed for the nearby transmission lines.	Limiting development to previously disturbed lands could limit traffic and road impacts to areas near existing roadways and access roads that have been developed for other purposes.	Limiting development to previously disturbed lands and within 10 miles of existing and proposed transmission lines could limit traffic and road impacts to areas near existing roadways and access roads that have been developed for the nearby transmission lines or for other purposes.
Tribal Interests (Section 5.18)	Common impacts: Tribal resources are subject to loss during construction, but impacts are also possible during operations. Impacts could occur from land disturbance during construction and depend on the location of facilities. Impacts may include destruction of important locations, sacred or archaeologically significant sites, habitat for culturally important plants and wildlife species, increases in human access and subsequent disturbance, and visual resource degradation, and noise. TCPs and Native American sacred sites as identified through consultation with Tribes and recognized by the BLM are excluded.					
	Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]	Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.18) may reduce the magnitude of impacts in comparison with the No Action Alternative.				
	The Los Mogotes SEZ in Colorado would remain in effect; solar energy development within the SEZ area would have high potential to cause significant impacts on Native American cultural and religious values.	The Los Mogotes SEZ in Colorado would be deallocated and the lands within the SEZ would no longer be available for utility-scale solar energy development. The deallocation of this SEZ would reduce the potential for future solar energy development to cause significant impacts on Native American cultural and religious values in this area.				
		Impacts from development to the RFDS level are expected to be similar under alternatives 1 and 2.		Limiting development to areas within 10 miles of existing and planned transmission lines could avoid new development in remote areas having Tribal significance and/or resources.	Limiting development to previously disturbed lands could avoid developing more remote lands that may have greater Tribal significance and/or resources.	Limiting development to previously disturbed lands and within 10 miles of existing and planned transmission lines could avoid new development in more remote lands that may have greater Tribal significance and/or resources.

<table>
<tr><th>Resource</th><th>No Action Alternative</th><th>Alternative 1</th><th>Alternative 2</th><th>Alternative 3</th><th>Alternative 4</th><th>Alternative 5</th></tr>
<tr><td rowspan="5">Visual Resources (Section 5.19)</td><td colspan="6">Common impacts: The construction and operation of utility-scale solar energy facilities may create visual contrasts with the surrounding landscape, primarily because they introduce large, complex, and visually distinctive human-made structures into existing landscapes. Visual impacts may include changes to visual values (e.g., scenic quality) and changes to the existing landscape character both as a result of the visual contrasts created by the facilities and public perception of those changes.</td></tr>
<tr><td>Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]</td><td colspan="5">Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.19) may reduce the magnitude of impacts in comparison with the No Action Alternative.</td></tr>
<tr><td>1% of the acres available are inventoried Scenic Quality Class A acres, 8% are Class B and 11% are Class C.</td><td>2% of the acres available are inventoried Scenic Quality Class A, 12% are Class B and 14% are Class C.</td><td>Less than 1% of the acres available are inventoried Scenic Quality Class A, 6% are Class B and 11% are Class C.</td><td>Less than 1% of the acres available are inventoried Scenic Quality Class A, 4% are Class B and 7% are Class C.</td><td>Less than 1% of the acres available are inventoried Scenic Quality Class A, 1% are Class B and 3% are Class C.</td><td>Less than 1% of the acres available are inventoried Scenic Quality Class A, 1% are Class B and 2% are Class C.</td></tr>
<tr><td>Lands available for application in the five states not included in the 2012 Western Solar Plan are not constrained by slope. Thus, development in those states could occur on sloped land resulting in increased visual impact.</td><td>Lands available for application would not be limited by slope. Thus, development could occur on sloped land resulting in increased visual impact</td><td colspan="4">Limiting development to slopes less than 10% would reduce the potential impacts because many sensitive visual resource areas (SVRAs) are in or near high-slope areas and because the larger viewing angle of solar facilities in high slope areas would mean greater visibility from valley floors, plains, other flat areas, and elevated viewing locations.

Changing the slope exclusion criterion from 5% to 10% slope could result in greater impacts for Alternatives 2-5 in comparison with the No Action Alternative for the six states under the 2012 Western Solar Plan.</td></tr>
<tr><td>Lands available for application are not limited by transmission proximity or previous disturbance, and thus visual impacts would not be concentrated in areas that already have reduced scenic quality.</td><td colspan="2">Lands available for application would not be limited by transmission proximity or previous disturbance, and thus visual impacts would not be concentrated in areas that already have reduced scenic quality.</td><td>Limiting development to within 10 miles of existing and planned transmission lines would reduce impacts because at shorter distances the presence of existing and planned transmission lines would have already reduced scenic quality or had impacts on nearby SVRAs.</td><td>Limiting development to previously disturbed lands would reduce impacts, because these lands would likely already have reduced scenic quality.</td><td>Compared to Alternatives 1–4, Alternative 5 would likely result in reduced impacts on scenic quality and SVRAs because it combines both impact reduction factors discussed for Alternatives 3 and 4.</td></tr>
<tr><td rowspan="2">Water Resources (Section 5.20)</td><td colspan="6">Common impacts: PV solar facilities require smaller volumes of water for panel washing and potable water uses than do other utility-scale solar technologies. Potential impacts include modification of surface and groundwater flow systems, water contamination resulting from chemical leaks or spills, and water quality degradation by runoff or excessive withdrawals. Impacts from development to the RFDS level are expected to be similar under all alternatives.</td></tr>
<tr><td>Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]</td><td colspan="5">Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.20) may reduce the magnitude of impacts in comparison with the No Action Alternative.</td></tr>
<tr><td rowspan="3">Wildland Fire (Section 5.21)</td><td colspan="6">Common impacts: Significant impacts could occur if wildland fire started at solar energy facilities, particularly in areas designated with high burn probability and CFWI (also known as the Fire Weather Index, FWI) values. Impacts from development to the RFDS level are expected to be similar under all alternatives.</td></tr>
<tr><td>Design features are required for the six states under the 2012 Western Solar Plan; for the remaining five states, mitigation is established on a project-specific basis. [a]</td><td colspan="5">Updated and more prescriptive design features required for the 11-state planning area (see Appendix B, Section B.21) may reduce the magnitude of impacts in comparison with the No Action Alternative.</td></tr>
<tr><td>In the last 20 years, California, Washington, and Idaho have been the most impacted by wildland fires; more than 20% of lands have had at least one wildland fire event. At least 10% of lands in Idaho and Washington have had at least two wildland fire events.</td><td>In the last 20 years, Washington, Idaho, and California have been the most impacted by wildland fires. Approximately 35% of lands available in Washington and 8% of lands available in Idaho and California have burned in wildland fire events. As these lands have burned within the last 20 years, there is a higher probability that they will burn again due to wildland fires.</td><td>In the last 20 years, Washington and Idaho have been the most impacted by wildland fires. Approximately 11% of lands available in Washington and 7% of lands available in Idaho have burned in wildland fire events. As these lands have burned within the last 20 years, there is a higher probability that they will burn again due to wildland fires.</td><td>In the last 20 years, Washington and Idaho have been the most impacted by wildland fires. Approximately 8% of the lands available in Washington and 5% of the lands available in Idaho have burned in wildland fire events. As these lands have burned within the last 20 years, there is a higher probability that they will burn again due to wildland fires.</td><td>In the last 20 years, Washington and Idaho have been the most impacted by wildland fires. Approximately 7% of the land available in Washington and 3% of the land available in Idaho have burned in wildland fire events. As these lands have burned within the last 20 years, there is a higher probability that they will burn again due to wildland fires.</td><td>In the last 20 years, Washington and Idaho have been the most impacted by wildland fires. Approximately 5% of land available in Washington and 2% of land available in Idaho have burned in wildland fire events. As these lands have burned within the last 20 years, there is a higher probability that they will burn again due to wildland fires.</td></tr>
</table>

[a] Design features established in the 2012 Western Solar Plan are only applicable to the six states within that planning area: Arizona, California, Colorado, Nevada, New Mexico, and Utah. These design features are not applicable to the five states addressed in this Solar Programmatic EIS that were not addressed in the 2012 Western Solar Plan (Idaho, Montana, Oregon, Washington, and Wyoming).
[b] Big game migration corridors as identified from USGS and currently applicable state agency sources.

2.5 Selection of Preferred Alternative

The BLM has selected Alternative 3 as the preferred alternative for this Draft Solar Programmatic EIS.

Alternative 3's focus on lands proximate to transmission meets the BLM's objective of guiding applications for utility-scale solar energy development on BLM-administered lands to areas with generally lower resource conflicts that are also closer to potential transmission infrastructure connection. , Proximity to transmission infrastructure is one of the most important site characteristics for successful utility-scale solar energy deployment. The resource-specific comparisons presented in Chapter 5 illustrates that Alternative 3 would generally avoid and minimize land disturbance, and reduce habitat fragmentation, resource degradation, and environmental and cultural resource impacts. Alternative 3 identifies lands as available for application where, based on its extensive solar permitting experience, the BLM expects to receive the majority of applications. Alternative 3 provides ample acreage needed to support estimated future development under the RFDS projections and helps fulfill the goals of the Energy Act of 2020, E.O. 14008, and E.O. 14057.

While Alternative 5 also focuses on lands proximate to transmission and includes more available land than the RFDS indicates will be needed for future solar development, Alternative 3 provides a larger margin of siting flexibility to avoid important resources and uses where the available public lands ultimately be determined unsuitable for solar energy development through site-specific environmental reviews. The BLM believes that the substantially larger amount of land available under Alternative 3 is needed to support future solar energy development and provide sufficient flexibility for solar energy developers to address potential local siting constraints and meet technical development requirements.

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3 Overview of Photovoltaic Systems, Development Considerations, and Regulations

This chapter explains key background and assumptions underlying the analysis in this Programmatic EIS, including general information about the characteristics of PV solar energy facilities that are likely to be developed in the United States over the next 20 years, including their sizes and resource needs (Section 3.1); a general description of the phases of PV solar energy facility development (from site characterization through decommissioning) and of associated transmission line development (Section 3.2); and a discussion of regulatory requirements and agency processes pertaining to solar energy facilities (Section 3.3). The concentrating solar technologies (including parabolic trough, power tower, and dish engine) that were evaluated in the Western Solar Plan are no longer prevalent technologies and are not addressed in this Programmatic EIS.

3.1 Photovoltaic Systems Technology

3.1.1 Technology Overview

A PV cell is a device that converts sunlight directly into electricity using semiconductors, which are materials that can generate electric current when exposed to sunlight. Many PV cells connected together form PV panels (also called modules). Focused PV technology development in the United States began in the 1950s and focused on space satellite and remote location applications where grid connection was impractical. Around 2010, silicon PV panel costs became low enough to stimulate rapid development of utility-scale PV facilities worldwide. Utility-scale facilities are larger facilities generating electricity that will be delivered into the electricity transmission grid; for this Programmatic EIS the BLM is considering projects 5 MW and larger to be utility-scale.

The information contained In this section is extracted from a more detailed discussion in Appendix I regarding utility-scale PV solar energy technology. Information that is most relevant to potential environmental impacts associated with the generation of electricity using PV solar is presented in the following sections.

PV solar energy systems, with an anticipated operational lifespan of over 20 years, are deemed the most likely solar technology to be deployed at utility scale over the next 20 years. In utility-scale PV facilities, PV panels are mounted to the ground at either a fixed angle or on a tracking device that follows the sun’s path through the day. Since 2015, most utility-scale PV solar energy systems have used single-axis tracking systems (Figure 3.1-1). Many solar panels are grouped together into solar arrays that produce direct current (DC) electricity. This modular nature of PV systems allows greater flexibility in sizing facilities based on factors like the amount of power needed or the amount of land area available. For large PV solar energy facilities, hundreds or thousands of solar arrays are interconnected to form a utility-scale PV system. The power-producing components of utility-scale PV facilities are the solar field, which contains the PV panels, and the power conditioning system, which contains inverters to convert the produced electricity from DC to AC and a transformer to boost voltage for feeding into the power grid. The PCS also contains devices that can sense grid destabilization and automatically disconnect the PV facility from the grid, if needed.

PV systems are based on the use of semiconductors, materials that can generate small amounts of electric current when exposed to sunlight. Semiconductors are materials that hold their bonding electrons tightly in covalent bonds (and therefore act as insulators in their pure state), but that have conducting properties when combined with small amounts of impurities called dopants.[1] Silicon, the second most abundant material in Earth's crust (after oxygen), was one of the first materials used to manufacture semiconductors and is still the most frequently used semiconductor today. Boron and gallium are common dopants. Researchers are currently using different combinations of semiconductors and dopants to increase the efficiency of solar cells for capturing the energy in sunlight. Other semiconductor materials used for solar cells include cadmium telluride (CdTe), copper indium diselenide, gallium indium phosphide, and gallium arsenide; however, after crystalline silicon technology, thin-film CdTe technology constitutes essentially all the remaining PV deployed for electricity grids worldwide and in the United States today. CdTe modules accounted for 34% of utility-scale PV capacity installed in 2022. Currently, silicon-based solar cells with efficiencies of 21 to 23% are likely to be used in utility-scale PV facilities built in the United States; however, multi-junction solar cells that contain two or more semiconductors and can increase efficiency to 30% or greater will likely be used in utility-scale PV facilities in the future. Efficiencies for CdTe modules are slightly lower than silicon-based modules at 19%. This Solar Programmatic EIS assumes the continued use of silicon and CdTe technology over the next 20 years; however, it is possible that other PV technologies may reach commercial viability during this period as well. In addition, emerging PV system configurations are being developed that co-locate solar with other uses such as agrivoltaics, pollinator-friendly PV, floating PV, PV over canals, and vertical PV.

Development of utility-scale PV facilities on BLM-administered lands has seen substantial growth over the past 11 years. As of December 2022, the BLM had permitted 41 solar energy projects, totaling 9,272 megawatts (MW) on approximately 73,000 acres of BLM-administered lands (BLM 2023g). In addition, as of May 2023 the BLM was processing over 100 applications for utility-scale PV solar energy facilities (BLM 2023h).

This Solar Programmatic EIS uses environmental documentation for a number of recent PV solar energy projects on BLM-administered lands to represent a range of projects and their associated parameters (Table 3.1-1).

[1] Dopants are substances added to a material in small amounts to alter its physical properties, such as electrical or optical properties (Wikipedia 2023).

Table 3.1-1. Representative Solar Energy Development Projects on BLM-Administered Lands

Project Name	Location	Technology	Capacity (MW)	Project Size (acres)	Water Use	No. Employees	Operating Status
Gemini Solar Project	Clark County, Nevada	PV and battery storage	690	7,100	• Construction: 2,000 ac-ft • Operation: 20 ac-ft/yr	• Construction: 1,700–2,000 • Operation: 7	Pending construction
Luning II Solar Energy Project	Mineral County, Nevada	PV	70	575	• Construction: 9.2 ac-ft • Operation: 0.75 ac-ft per wash	• Construction: 50–75 • Operation: N/A[a]	Pending construction
Oberon Renewable Energy Project	Riverside County, California	PV and battery storage	500	2,700	• Construction: 700 ac-ft • Operation: 40 ac-ft/yr	• Construction: 320 (average) • Operation: 10	Operational in 2023
Sonoran Solar Energy Project	Maricopa County, Arizona	PV and battery storage	260	3,432	• Construction: 1,000 ac-ft • Operation: 33 ac-ft/yr	• Construction: 372 (average) • Operation: 16	Pending construction
Sweetwater Solar Energy Facility	Sweetwater County, Wyoming	PV	80	584	• Construction: 71 ac-ft • Operation: 0.6 ac-ft/yr	• Construction: 10–125 • Operation: 6	Operational in 2019

[a] N/A = not available.

Sources: BLM (2018a; 2019c; 2021a,b,c).

The projects in Table 3.1-1 were selected to represent the wide range of potential PV solar energy projects that could be developed on BLM-administered lands within the next 15 to 30 years. Four of the five projects are located in the states covered in the Western Solar Plan and include the Gemini Solar Project and the Luning II Solar Energy Project in Nevada; the Oberon Renewable Energy Project in California; and the Sonoran Solar Energy Project in Arizona. The Sweetwater Solar Energy Facility is an operational PV solar energy facility in Wyoming. The Gemini Solar Project is the largest, with a nameplate capacity of 690 MW; the Luning II and Sweetwater solar energy projects are the smallest, at 70 MW and 80 MW, respectively.

The land use requirements for these five representative projects range from 5.4 to 13.2 acres/MW, with an average of 8.9 acres/MW (based on the total right-of-way [ROW] area permitted, divided by nameplate capacity). Other ROW applications and authorizations for PV facilities on BLM-administered lands may include a larger range of land areas, depending on a number of factors including road and transmission line construction, battery storage facilities, and other ancillary facilities. In general, ROW applications include a larger area than will actually be needed for a facility (see land use discussion in Section 3.1-2).

The system components involved in equipment required for PV facilities can be installed on sloped ground, tolerant of slope change, depending on the flexibility of the interconnection between panels. Some emerging all-terrain/articulated PV tracking system technologies are emerging that can accommodate steeper slopes, but in general, construction and operation are will be more complex on steeply as sloped land increases (e.g., greater than 8–10%; Hassan 2021; Munkhbat 2021). Some studies have found that lands with up to 10% slope may be suitable for solar energy development (Nebey 2020; SolSmart 2017). Although areas with up to 10% slope are available for application under all of the Action Alternatives, site-specific evaluations of potential for soil erosion and other impacts associated with construction in higher sloped areas would be required prior to decision to approve development.

The estimated water requirements during construction for the representative recent projects in Table 3.1-1 range from 0.13 to 3.9 ac-ft/MW, with an average of 1.8 ac-ft/MW. Water is used during facility operations to wash solar panels when necessary and for miscellaneous industrial processes and sanitary uses to support the workforce. The operations water use requirements for projects in Tabe 3.1-1 range from 0.008 to 0.13 ac-ft/yr/MW, with an average of 0.05 ac/ft-yr/MW.

The estimated average number of construction jobs for the representative recent projects ranges from 0.6 to 2.7 jobs/MW, with an average of 1.3 construction jobs/MW. The operations estimated jobs for projects in Table 3.1-1 range from 0.01 to 0.08 jobs/MW, with an average of 0.03 operations jobs/MW.

Battery Energy Storage Systems (BESSs). PV facilities with BESSs allow surplus energy to be captured during times of high production (e.g., during daylight hours) and stored for use during times of low production or high demand (e.g., during evening or nighttime hours). Battery storage is an essential component of large-scale solar development. The intermittency of solar energy production can be a challenge for grid operators, as it can lead to power fluctuations and instability. Battery storage systems can help address this issue by storing excess energy generated during peak production times and releasing it during periods of low production. This helps to ensure a more consistent and reliable supply of energy to the grid. In addition, battery storage systems can help to reduce the need for fossil fuel-based peaker plants, which are used to meet peak demand periods. By providing a reliable source of energy during these periods, battery storage systems can help to reduce GHG emissions and promote the use of renewable energy sources.

Battery storage is becoming increasingly prevalent in solar development. In the United States, over 60% of the 10 GW of battery storage capacity expected to be added in the next two years will be paired with solar facilities. In 2021, 3.1 GW of battery storage capacity was added in the United States, a 200% increase from the previous year. The International Energy Agency estimates that United States will have 175 GWh of battery storage capability by 2026 (IEA 2021a).

The BLM has seen a substantial increase in PV energy facility applications that include utility-scale BESS technology as a component of the proposal. While currently no PV energy facilities on BLM-administered lands include utility-scale BESS technology, five PV solar energy projects with BESSs have received ROW authorization. The BLM issued a ROD for the Gemini Solar Project in May 2020, approving the construction, operation, maintenance, and decommissioning of a 690-MW PV solar power generating facility with battery storage on BLM-administered lands in Clark County, Nevada (BLM 2020a). Most recently, the 500-MW Oberon Solar facility, that includes 250-MW of battery storage, became operational in late 2023. In general, BESSs allow for a more continuous supply of electricity. BESSs are described in further detail in Appendix I, Section I.3.

3.1.2 Assumptions Used for Environmental Analyses

Some important factors affecting environmental impacts of solar energy development include the overall size of the facilities, water use during construction and operations, and employment during construction and operations. Assumptions used for these parameters to support analysis of impacts in this Solar Programmatic EIS are presented in Table 3.1-2 and discussed below.

Information on the range of capacities for PV facilities on BLM-administered lands was obtained from BLM's list of operating or pending construction solar energy projects as of December 2022 (BLM 2023g), and from BLM's list of pending applications (BLM 2023h). Although several old projects were small (under 5 MW), all projects since 2020 have been greater than 5 MW, and no pending projects have capacities less than 100 MW. About 15% of pending applications are for facilities with capacities of greater than 750 MW, with individual applications as high as 4,000 MW. It is uncertain whether the BLM will permit solar facilities of this magnitude.

This analysis presents impacts for solar energy facilities with nameplate capacities of 5 to 750 MW. To date, the BLM has issued ROW authorizations for PV solar energy facilities that range from less than 1 to 690 MW; a high-end capacity of 750 MW is presented in this Programmatic EIS although pending applications include larger facilities. Given the modular nature of PV facilities, the land and water use of larger facilities would be proportional to their capacities. The range of 5–750 MW is used as a representative size range for PV solar energy facilities; however, water and land use (and corresponding impacts) can be estimated for larger facilities by using the parameters in Table 3.1-2 on a per-megawatt basis.

The average nameplate capacity for utility-scale solar PV installations that were placed in service in 2021 was 88 MW; 92% of the installed capacity in 2021 came from systems greater than 50 MW and 63% from systems greater than 100 MW (EIA 2022a). For perspective on the capacities of other electricity sources, in 2021 the average nameplate capacity for individual facilities was 311 MW for coal-fired power plants, 1065 MW for nuclear plants, 90 MW for wind facilities, and 87 MW for natural gas facilities (EIA 2022b). The U.S. utility-scale electricity generating capacity for all energy sources in 2021 was about 1.2 million MW (1,200 GW) (EIA 2022c).

Table 3.1-2. Assumptions for Impact Analyses

Parameter[a]	Value
PV Facility power capacities (MW)	5–750
Land area requirements—PV (acres/MW)[b]	4–7
Land area requirements—PV with battery storage (acres/MW)	5–8
Construction water use (ac-ft/yr/MW)[c]	0.13—3.9
Operational water use (ac-ft/yr/MW)[d], panel washing/other	0.05–0.35
Number of direct and indirect jobs, for a 5—750 MW facility[e]	Construction: 26–1,776 Operations: 1–233

[a] Given the modular nature of PV facilities, land and water use and direct and indirect jobs created would be proportional to the facility capacity. Therefore, these items can be estimated for facilities larger than 750 MW using parameters in this table.

[b] Land area estimates were based on operational and pending-construction facilities on BLM-administered lands (BLM 2023g).

[c] From Table 3.1-1.

[d] From Section 5.20.

[e] From Table 5.15.1-1.

*Land Requirement Assumptions***.** The assumptions for land area requirements given in Table 3.1-2 are based on a review of land use for existing and proposed facilities on BLM-administered lands. The assumed land use range is less than the average for representative facilities presented in Table 3.1-1 because applications for solar energy ROWs on BLM-administered lands preliminarily request substantially more land area than would correspond to what will ultimately be needed for development. The environmental considerations and rationales for requesting additional acreage up-front include maintaining flexibility for project adjustments and siting configuration to avoid lands where resource conflicts might exist within the ROW. The rationales for requesting additional acreage include allowing flexibility in project design or to avoid lands where resource conflicts might exist within the ROW. Additionally, siting flexibility is needed due to financial and technical considerations that may require a developer to adjust their proposal. For example, it is likely to be appropriate to avoid areas within the facility footprint that serve as natural drainage swales or to avoid uneven or inappropriately sloped areas to preempt the potential impacts from that would occur from the development of such areas.

The majority of land for any solar energy facility is devoted to the solar field. To ensure optimal operation, it is necessary to place individual sun-capturing devices in the solar field with sufficient separation to avoid shadowing of one device by an adjacent device. Providing for adequate spacing and for access roads needed for inspection, maintenance, and repair contributes substantially to land area requirements. It is also essential to provide sufficient land areas for all components of the facility in addition to the solar field, such as other linear facilities within the site (e.g., electricity lines, water pipelines, or telecommunications), substations, and operation and maintenance buildings. Land use requirements expand when BESSs are introduced. This Solar Programmatic EIS assumes an additional 1 acre/MW for BESSs, based on land use for BLM-approved projects that include BESSs (BLM 2023g).

ROWs may also include buffer zones on fallow land surrounding solar energy facilities may be appropriate for a variety of reasons, including control of land use to prevent the erection of facilities on adjacent land areas that could interfere with the operation of the solar energy facility, or to provide for the attenuation of noise from industrial activities at surrounding human or wildlife receptor locations. The size of ROWs for individual facilities is established as a part of the BLM's site-specific evaluation process.

Water Use Assumptions. Water use during construction is dependent on the location of a project and the specific project design and includes water use for dust suppression. Assumed values for construction water use were based on the representative projects presented in Table 3.1-2. Information from the scientific literature was used to develop representative values for operational water use (see Section 5.20). PV solar technology does not require consumptive water use for operations; operational water use is limited to panel washing, potable use by employees, and other general uses for facility operation and maintenance. Facilities in dry environments may consider alternative water sources for panel washing, but such water could also require extensive treatment for adequate performance in panel washing (e.g., if wastewater were used).

Employment Assumptions. The number of direct and indirect jobs created during construction and operations is discussed in Section 5.15 and presented in Table 3.1-2.

3.2 Development Phases

3.2.1 Site Characterization

Site characterization is critical to the overall success of the project in avoiding or minimizing adverse impacts. Surveys of existing ecosystems and identification of other important resources or features completed during site characterization provide data that are critical in supporting facility designs and development plans that minimize overall impacts. Impacts from site characterization activities could range from insignificant to moderate, depending on specific needs. However, in most instances site characterization will result in only small or negligible impacts.

In general, very little in the way of site modification is necessary during the site characterization phase. Required activities would vary depending on the project location, size, and requirements of Power Purchase Agreements (PPAs). The activities could include construction of meteorological towers or instrumentation facilities (or erection of portable, trailer-mounted towers) for collection of meteorological data, surface hydrology assessment and floodplain mapping, slope evaluation, soil stability studies, due diligence assessment for lands with previous industrial uses, evaluation of seismic stability and potential storm event runoff, and soil coring. The site characterization phase would include conducting surveys for ecological, cultural, and paleontological resources (including surveys for special status species, if needed). Many of these activities would involve minimal or no site disturbance. For example, solar insolation data collection, surface hydrology assessment, floodplain mapping, slope evaluation, and due diligence assessments would primarily involve literature searches and/or onsite walkover surveying techniques and sensor placement. Most soil stability and soil coring activities would involve the use of handheld augers that could be transported to the site on existing roads. Ambient sound measurements that may be required for acoustic impact assessments are typically noninvasive and involve very little or no site disturbance.

Meteorological information (e.g., temperature, precipitation, and wind speed) might be obtained from a nearby existing monitoring station, or a meteorological tower could be erected onsite to collect site-specific data. The required height of a meteorological tower in most cases would likely be 33 to 66 ft (10 to 20 m), since the main wind data required would be for estimating potential wind-shear impacts on facility equipment. It is estimated that it would take less than a day to erect a tower. Towers and instruments are relatively lightweight and often do not require belowground foundations or guy wires, especially if they are to be in service for limited periods of time. Towers typically do not require signal lights, particularly the shorter 33- to 66-ft (10- to 20-m) towers. Some monitoring towers could remain operational throughout the life of the site and would then require a more permanent installation during the construction phase. In locations where high winds or wind shear is likely, permanent installations may require guy wires to ensure adequate structural support for the towers. For these towers, subsurface foundations may be required. Remote sites may require construction of a minimum-specification access road, which may be upgraded later to become the site's main access road, to support meteorological tower installation. A small crew (six or fewer individuals) would be required to erect the meteorological towers, but typically no personnel support facilities would be required. Data collected during equipment inspections or for maintenance purposes would be transmitted to remote locations; thus, only infrequent human presence would be required onsite during data collection.

For solar energy projects that anticipate using groundwater obtained from onsite wells, existing area-specific data on groundwater hydrology may suffice in lieu of onsite characterization data. However, in the absence of area-specific data, more extensive ground-disturbing activities, such as installation of monitoring/sampling wells and piezometers, could be required. Large truck-mounted drilling rigs might require wider, higher-specification site-access roads and could cause more extensive site disturbance. An appropriately sized and equipped drilling rig, used in conjunction with proper drilling procedures and site management, could minimize such impacts. Additional surface disturbance associated with well drilling could result from the construction of temporary impoundments for well drilling fluids and cuttings, although if closed-loop drilling systems were used, surface impoundments would not be necessary. Improper management of drilling fluids and cuttings could result in surface water and localized soil impacts.

3.2.2 Site Preparation

A site preparation phase is generally the first of two construction phases. A relatively short duration (e.g., a few months) site preparation phase is typically followed by a much longer assembly, testing, and start-up phase. The components and activities required for construction are dependent on both project size and location. Development strategies and construction schedules are also site-dependent. Although smaller solar energy facilities in the range of 5 to 50 MW may be constructed in a year or less, larger facilities may have construction periods of several years and may be developed in phases. Whenever possible, developers would likely develop sites in an efficient manner that leverages economies of scale. For example, where possible, similar activities would likely be completed at the same time throughout the entire site. Specialty crews could be brought to the site to complete all of their functions throughout the site, such as ground preparation, installing foundations, or installing electrical equipment and substations, at one time.

PV solar site preparation consists of establishing site access, site clearing and, in some cases, grading. Major heavy equipment that may be used in the site preparation phase would include bulldozers, graders, excavators, scrapers, front-end loaders, trucks, cranes, rock drills, mowing equipment, chain saws, chippers, trenching machines, and equipment for blasting operations, if required. Until recently, applications for PV solar energy facility ROWs generally specified vegetation removal for the entire solar field area, to reduce fire hazards and simplify construction. However, some construction techniques can minimize land surface disturbance, by setting grading limits, setting restoration and revegetation recovery standards, leaving natural contours of the site in place, utilizing site access plans to minimize disturbance of vegetation and soil, and trimming vegetation rather than removing it. Recent projects on BLM-administered lands that utilize such techniques include the Gemini Solar Project (BLM 2019c; 2020a), the Yellow Pines Solar Project (BLM 2020c), and the Oberon Solar Energy Project (2021b). For these projects, the BLM required that vegetation removal and soil disturbance be minimized to the extent possible. Replacing more disruptive site preparation techniques like 'grading' and 'disk and roll' with less intrusive measures such as 'overland travel' within solar panel array areas can reduce adverse ecosystem impacts without significantly impeding project development or impacting worker safety.

All authorized ground disturbances would be confined to the ROW. Vegetation must be cleared from areas around electrical substations and control buildings to allow access and eliminate fire and electrical safety hazards. These areas are likely to be covered in rock or gravel to ensure all-weather accessibility and proper drainage, and to reduce fugitive dust.

Soils in certain portions of the solar energy facility sites would be expected to be compacted as a result of construction and vehicle traffic. Once construction is completed, areas cleared for construction purposes would be revegetated, and updated design features now require that seed mixes that include native species be used to the extent possible. The success of revegetation would depend on the location of the solar energy facility; in desert areas, revegetation is not readily achieved (see Section 5.4.1).

Road specifications would be dictated by the weights of the heaviest components, for example, electrical transformers. While straight-line access roads would minimize distance and cost, heavy loads may dictate a maximum grade of 10%, so some access roads may need to follow circuitous routes to meet grade requirements. Other factors, such as streams, areas of particular environmental sensitivities, and immovable obstacles, would also affect access road location. Nearby rail access may necessitate the establishment of a temporary equipment storage area at an offsite railhead, but it may also dramatically reduce truck transport requirements. Water transport is generally not expected to occur but could be needed for wildfire response or dust control.

In general, the heavy equipment and materials needed for road construction activities would not pose unique transportation considerations for existing roads. However, offsite road construction or improvements may be required if local roads necessary for site access are not designed for gross vehicle weights of up to 80,000 lb. (36,000 kg), the federal limit for tractor-trailer trucks on most U.S. highways. Also, state-specific and local limits may apply. Local transportation authorities would be contacted to ensure approved truck routes are used and proper signage is placed to notify the public of any traffic hazards.

Although some solar energy facilities could be accessed through gravel roads, in general the primary onsite access road(s) connected to the local road system would be a paved two-lane road because it would need to accommodate a large daily construction workforce and delivery traffic flow (as discussed in Section 5.17). Such an access road would reach as far as parking areas (paved or nonpaved) for construction workers, laydown areas for equipment and supplies, or other major site locations. In accordance with design standards for local roads and streets, these primary access roads may have lane widths of 10 ft (3 m), with graded 5-ft (1.5-m) shoulders as recommended for average daily traffic volumes greater than 400 vehicles (AASHTO 1994), for an overall road width of 30 ft (9 m). A ROW approximately twice the final width of an access road would be required. Therefore, if access road construction were required, the construction ROW width would likely be approximately 60 ft (18 m) and result in a disturbed area of about 7 acres (0.03 km^2) per mile of road constructed.

In contrast, most of the onsite roads are expected to be one-lane dirt or gravel roads that provide access to the solar field and transmission lines. Typically, these onsite access roads would be a minimum of 10 ft (3 m) wide (PBS&J 2002). In arid zones, compacted gravel roads may cause fugitive dust problems (e.g., PM_{10} and $PM_{2.5}$; see Section 5.2). BMPs to mitigate road dust could include the application of water or soil palliatives (see Appendix B, Section B.2). Natural drainage patterns could be altered, at least on a local scale, so engineered stormwater control is generally necessary.

Construction of access roads would require removing vegetative cover. Clearing the road path may involve tree removal in some locations. Depending on subsurface stratigraphy, surface soils may need to be excavated, and gravel and/or sand may need to be imported to establish a sufficiently stable road base. Topsoil should be removed and stockpiled for subsequent use to meet the needs of any identified or required interim reclamation.

3.2.3 Site Construction (Assembly, Testing, and Start-Up)

Construction of any solar energy project is likely to involve the following major actions: ground preparation of the solar field area (mowing and/or contouring); grading in some portions of the site; constructing temporary laydown and parking areas; constructing the solar field; constructing the operation and maintenance building, electrical substations, and meteorological towers (if not done during site characterization); and constructing linear facilities (gen-tie lines, and for larger facilities possibly water lines). The major equipment used in the construction phase would include cranes, front-end loaders, backhoes, bulldozers, and trucks. In general, the vehicles, equipment, and materials needed for construction would not pose unique transportation considerations or impacts on existing roads.

Foundation Excavation and Installation. The foundations required for control and administrative buildings would require only slab-on-grade foundations. Geotechnical surveys involving numerous soil borings may be needed to establish foundation specifications. The shallow foundations for control and administrative buildings generally would not require drilling or blasting. Excavated materials would likely be stockpiled on site and reapplied in disturbed areas. Most components of the solar field, such as PV panels, would require minimal foundations, with many simply having preformed concrete feet resting on the ground surface. The solar tracker/mount installations would be constructed using either driven steel posts, screw piles, or possibly concrete foundations if required.

The concrete for foundations could be trucked to the site, or a temporary concrete batching plant could be constructed. Constituents of the concrete (aggregate, sand, cement, and water) would need to be hauled to the batching plant. Electrical power for the batching plant likely would be provided by a portable diesel engine/generator set (nominally, from 125- to 1,250-kW capacity). The land area required for a typical batching plant and associated material storage areas is typically approximately 10 acres (0.04 km^2) or less. Surface vegetation would need to be removed, and some regrading of surface soils in the batching plant area might be required. Soils would be expected to be heavily compacted as a result of batching plant activities and associated truck traffic. The batching plant and any excess concrete constituents would likely be removed at the end of the concrete-placing phase.

Other Construction Activities. Additional construction activities would include installation of electric substations and trenching for power and signal cables. Conventional construction methods are expected to be sufficient for these activities.

An operations and maintenance building and additional storage building for parts and equipment might also be constructed. Some limited amount of maintenance or repair for solar array components might also be provided for, in conjunction with parts and equipment storage.

Power-conducting cables and signal cables would interconnect the solar field with the electrical substation. Where the soil mantle permits, the preferred method would involve burial of cables to a nominal depth of 4 ft (1.2 m). Standard trenching techniques are expected to be sufficient. However, on rocky sites where trenching is not possible or is too difficult, it may be necessary for the cables to be suspended in cable trays generally located from 1 to 3 ft above ground.

No major maintenance is expected to be performed onsite on construction equipment; however, fluid levels would be maintained onsite for vehicles and equipment that are not roadworthy. Fuel for construction vehicles and equipment would be stored in portable aboveground tanks throughout the construction period. Lubricants to support equipment would likely be stored in portable containers inside the storage building.

During the construction phase, potable water and sanitary facilities would need to be established to support the construction crews. Potable water probably would be provided from offsite sources. Sanitary facilities would most likely be provided through portable latrines. The major water use would be for dust minimization through spraying of disturbed areas (for example, where vegetative cover is removed, or where vehicle traffic and material handling occurs). The water could be purchased from a nearby municipality and trucked daily to the site. Where no such sources are readily available, it is possible that water may be obtained from nearby surface water features or onsite wells. Surface drainage diverted to onsite impoundments may also be a source of water for dust control. Precisely coordinated construction schedules, prompt installation of onsite roads, posted and enforced maximum onsite speed limits, and limitations on certain activities during windy periods could also be employed to mitigate the impacts of fugitive dust from surface-disturbed areas. However, depending on the meteorological conditions at a site, fugitive dust generation during construction may be difficult to control if large areas are cleared for solar fields.

Temporary fences or barricades may need to be erected during some periods of the construction phase in accordance with applicable Occupational Safety and Health Administration (OSHA) regulations, in order to prevent unauthorized entry of individuals or animals into hazardous active construction zones and to provide for the safety of the construction workforce during periods when open excavations are present. Temporary construction facilities would be removed when no longer required, and the areas reclaimed.

In general, the entire solar project area, including solar fields, would be fenced. Electrical substations and power blocks would require fencing for security and safety. Various fence designs can be expected. High-hazard areas such as electrical substations may be enclosed with 8-ft (2-m) chain-link fence topped with barbed wire or razor wire to control unauthorized entry. Perimeter fencing may be low-maintenance barbed wire fencing or chain-link fencing, with some applications including fabric inserts. Some facilities may lift the perimeter fence or add passages after construction is complete in order to allow small animals that are not likely to cause damage to facility components to pass through (for example, desert tortoise and kit foxes).

3.2.4 Operations and Maintenance

Operation of PV solar energy facilities would require a small number of onsite personnel, but the precise number would depend on the facility’s capacity. For example, smaller PV facilities could be monitored remotely with no staff present on a daily basis. Larger facilities could require some staff to be present on a daily basis (see Table 3.1-2). All facilities would require facility control staff to periodically monitor the solar array and substation operations during daylight hours.

Common maintenance requirements would include panel washing, ensuring panels are tracking properly, preventive maintenance, and mowing in some regions. In general, developers plan for at least annual panel washing.

Vegetation would be maintained on-site through a combination of mowing or trimming native species and herbicide application on non-native or noxious species. Native vegetation in areas that were mowed during construction would be maintained at an appropriate height by mowing or trimming once or twice a year, as necessary. Equipment includes a commercial-sized raised deck mower, or similar. A bush hog or similar equipment typically is not needed but could be used in limited areas if vegetation becomes thick.

3.2.5 Decommissioning/Reclamation

The BLM requires a solar applicant to post a performance and reclamation bond as a condition of approval and authorization issuance. The value of this bond would be determined commensurate with the specific solar development project. Additionally, a Decommissioning, Abandonment, and Site Reclamation Plan is required to be submitted to the BLM prior to a developer being provided a Notice to Proceed into construction. This plan would be updated and approved by the BLM prior to any decommissioning activities.

At the end of a PV solar energy facility's operational life, decommissioning is expected to proceed in accordance with a preapproved plan that would include removal of most if not all equipment; removal of permanent structures and improvements (including onsite and access roads); proper closure of all onsite wells; removal of all hazardous materials and wastes and closure of related storage areas according to applicable requirements (including a separate closure plan for hazardous waste storage areas); remediation of all spills or leaks of chemicals that may occur during emptying or dismantlement of components; closure of all offsite material storage areas; and return of the site to its native state to the greatest extent possible, including re-establishment of the native vegetative communities. All components of solar fields would be dismantled and recycled, sold for scrap, or disposed of offsite as solid waste (some PV panels might be classified as hazardous waste and would have special disposal requirements; see Section 5.20). PV panels are expected to be removed from the solar array without disassembly at the site. Inadvertent breakage of some PV panels during dismantlement may require remediation of hazardous constituents released to the environment. Electrical power management and conditioning equipment, as well as components of BESSs, would be recycled or disposed of (in some cases as hazardous waste because of the heavy metals present). Transformers and electrical control devices would either be reused in other applications or sold as scrap after fluid removal. Belowground cable runs are expected to be left in place, provided their presence would not intrude on agreed-upon site revegetation plans.

The access road, onsite roads, rock or gravel in the electrical substations, transformer pads, and building foundations would be removed and recycled if no longer needed. Concrete slab foundations would be broken up. Broken concrete could be used by highway departments for road base or bank stabilization. Disturbed land areas covered in rock or gravel or building footprints would be adjusted for their degrees of soil compaction, restored to original grade to the greatest extent possible, and reseeded or replanted using native vegetation to the greatest extent possible.

Dismantlement of electrical substations and storage buildings would be accompanied by inspection for and documentation of the presence of industrial contamination in the soil or surface water (if applicable) from spills or leaks, and decontamination as necessary. Soil testing and surface water testing should be conducted after decommissioning any site.

3.2.6 Associated Transmission

Construction and operation of transmission lines to tie solar energy facilities into the main power grid would be required for new PV solar energy facilities. The length of transmission line required would depend on the distance from the site to existing lines having sufficient uncommitted capacity to accept power from the facility. If transmission line construction is required to support solar energy facility development, the ROW width would likely be less than 250 ft (76 m), including additional width needed for construction (see Appendix I, Section I.4.3.4 for discussion of transmission ROW widths), which corresponds to a disturbed area of about 30 acres (0.12 km^2) per mile of transmission line constructed. Available transmission capacity is dynamic over time, thus project developers need to contact the appropriate transmission provider and comply with applicable interconnection procedures. This Solar Programmatic EIS does not evaluate the available capacity on existing lines (i.e., the analysis assumes lines could be upgraded if needed). Upgrading of existing lines would result in variable additional land disturbance, depending on the extent of upgrades needed. Upgrading existing lines would be advantageous to transmission operators because it may minimize the need for new entitlements on federal, state, or private lands, and because impacts would be minimized by avoiding new land disturbance. Analysis of the resource-specific impacts of onsite transmission line construction is provided in Chapter 5.

The voltage of transmission lines that would be built to connect solar energy facilities to the existing transmission grid is not known; however, transmission line ratings needed would likely range between 230 to 500 kV for interconnections from utility-scale solar energy facilities (500 kV is the predominant voltage for high voltage transmission lines in the western states). Regardless of the voltage of the connecting transmission lines, the solar energy facility operator would be required to condition the electricity being produced by the facility with respect to voltage and phase so that it would be compatible with the conditions on that portion of the grid to which the facility is connected, and as directed by the transmission system operator. Substation construction at the point of interconnection of solar energy facility power with the grid would also generally be required.

Transmission line construction times are dependent on such factors as accessibility to the ROW, the need to build roads over difficult terrain, or the need to substantially amend topography for staging erection cranes and cable-pulling equipment. For simple projects requiring minimal access road construction and ROW disturbance (e.g., only vegetation clearing and grading), construction of 5 mi (8 km) of transmission line would likely require a minimum of six months, assuming the availability of multiple crews. Actual construction time could exceed one year for more constrained projects on higher-sloped lands.

A good description of the activities required for construction, operation, and decommissioning of transmission lines can be found in Appendix G of the West-Wide Energy Corridor Programmatic EIS (DOE and DOI 2008). The general sequence of activities for placing electricity transmission lines would involve surveying, site clearing, construction of access roads, drilling or excavation for support structures and concrete footings, and backfilling. Tower structures would be carried to the site by truck in sections, assembled in laydown areas, and lifted into place with a crane. Depending on environmental and/or logistical factors (e.g., rugged, mountainous terrain), helicopters could be used for tower transport and erection, which would substantially reduce the construction period. Towers would require from one to four or more concrete foundations, depending on the type of tower and the subsurface conditions. Once towers are in place, truck-mounted cable-pulling equipment is used to string the conductors onto the support structures. Although substantively more expensive, conductors can also be installed with helicopters, a technique especially suited to rugged or steeply sloped terrain.

Construction of transmission lines would also require the establishment of tower assembly areas, laydown areas, and temporary roads. These areas would be reclaimed at the end of the construction period.

During the operation of transmission lines, inspection and maintenance of the cables and towers would be required. Inspections may be accomplished by personnel walking or driving the ROW and/or by aircraft. To prevent ground faulting, vegetation management using a combination of herbicides and physical clearing could be required along the ROW. In semiarid environments, tall vegetation that would threaten the operability of the transmission line is not likely to exist, so neither herbicides nor physical clearing would likely be necessary.

Decommissioning of transmission lines and substations would include removal of all equipment and permanent structures, remediation of all spills or leaks of chemicals, and return of the ROW to its native state to the greatest extent possible, including re-establishment of native vegetative communities. Metal and wooden tower components and conductors could be reclaimed for similar use, or recycled if appropriate recycling facilities could be identified.

3.3 Laws and Processes

3.3.1 Laws, Policies, Orders, and Plans

This section discusses in very general terms the existing major laws, EOs, regulations, and policies that may impose environmental protection and compliance requirements on the siting, construction, operation, and decommissioning phases of utility-scale PV solar energy projects. Because solar energy projects vary in terms of design, size, and location, not all the requirements described here may apply to all projects.

With respect to PV solar energy projects on BLM-administered lands, the BLM conducts its administration and management of this use-type in accordance with the Federal Land Policy and Management Act (FLPMA; 43 U.S.C. 1701–1785) and numerous other statutes, regulations, and standards related to environmental protection, hazardous materials transportation, ecological resource requirements, and cultural and paleontological resource requirements. BLM policies and guidance also guide the land use planning process, NEPA process, and solar energy ROW authorization processes.

In addition to requirements under federal laws, solar energy projects on public lands may also need to comply with state laws and county ordinances subsequent to federal approval. The BLM seeks to consider local ordinances as well as locally appropriate design features when evaluating project-specific solar proposals.

3.3.1.1 Laws and Regulations

- National Environmental Policy Act of 1969 (NEPA; 42 U.S.C. 4321)—When the BLM issues a ROW for a PV solar energy development project, it must comply with NEPA by preparing an environmental analysis that evaluates the direct and indirect environmental impacts of the project during construction, operation, and decommissioning activities as well as the cumulative impacts of the project alongside other past, present, and reasonably foreseeable activities. The NEPA analysis will generally include assessment of land disturbance, water use, air emissions, and potential impacts on natural, cultural, and biological resources, among other relevant resource impacts.
    - Council on Environmental Quality (CEQ) NEPA Regulations (40 CFR Part 1500)—The CEQ within the Executive Office of the President is responsible for developing procedures for federal agency implementation of NEPA.
    - DOI Implementation of the National Environmental Policy Act of 1969 (43 CFR Part 46)—Establishes procedures for the DOI bureaus and offices (including the BLM) to comply with NEPA regulations.
- Federal Land Policy and Management Act (FLPMA)—The BLM's "organic act" establishes the agency's multiple-use and sustained yield mandate to serve present and future generations. All BLM-administered land use planning efforts must comply with FLPMA requirements.

- BLM Land Use Planning Regulations (43 CFR Part 1600)—Provides BLM procedures for preparing and amending land use plans. All land use plan amendments proposed as a part of this EIS must comply with the procedures and processes outlined in these regulations.
- Rights-of-Way Under FLPMA (43 CFR Part 2800)—Establishes procedures for the orderly and timely processing of applications, grants, permits, amendments, assignments, and terminations for ROWs and permits for the use of BLM-administered lands pursuant to Title V of FLPMA.
- Proposed Rule: Rights-of-Way, Leasing, and Operations for Renewable Energy (88 FR 39726)—The BLM proposed regulations that would reduce existing acreage rents and capacity fees for solar and wind energy development, expand the BLM's ability to accept leasing applications in DLAs, and expand the BLM's ability to accept non-competitive leasing applications when in the public interest. The proposed rule would amend BLM's FLPMA ROW regulations (43 CFR Part 2800).
- Proposed Rule: Conservation and Landscape Health (88 FR 19583)—The BLM proposed new regulations pursuant to FLPMA to manage BLM-administered lands for multiple use and sustained yield. This framework would consider the health and resilience of ecosystems across those lands in BLM planning and decision making. The proposed rule would amend BLM's land use planning regulations (43 CFR Part 1600) and add new regulations focused on conservation (proposed 43 CFR Part 6100).
- ESA (16 U.S.C. 1531 et seq.)— Establishes protections for fish, wildlife, and plants that are listed as threatened or endangered; provides for adding species to and removing them from the lists of threatened or endangered species, and for preparing and implementing plans for their recovery; provides for interagency cooperation to avoid take (including killing, capturing, selling, trading, and transport) of listed species and for issuing permits for otherwise prohibited activities; and provides for cooperation with states, including authorization of financial assistance.
- National Historic Preservation Act (NHPA; 54 U.S.C. 306101 et seq.)—Intended to preserve historic properties in the United States. The NHPA created the *National Register of Historic Places*, the list of National Historic Landmarks, and the State Historic Preservation Offices. Section 106 of the NHPA requires federal agencies to consider the impacts on historic properties of undertakings they carry out, assist, fund, permit, license, or approve. If a federal or federally assisted undertaking has the potential to affect historic properties, a Section 106 review is required, including consultation with Tribes and state and Tribal historic preservation officers.
- Migratory Bird Treaty Act (MBTA; 16 U.S.C. 703 et seq.)—Intended to ensure the sustainability of populations of all protected migratory bird species. The MBTA prohibits the take (including killing, capturing, selling, trading, and transport) of protected migratory bird species.

- Bald and Golden Eagle Protection Act (BGEPA; 16 U.S.C. 668 et seq.)—Prohibits anyone without a permit from "taking" bald or golden eagles, including their parts (including feathers), nests, or eggs. The U.S. Fish and Wildlife Service (USFWS) issues and maintains permits for eagle take.
- Wild and Scenic Rivers Act (16 U.S.C. 1271)—Created the National Wild and Scenic Rivers System to preserve certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations. Rivers may be designated by the U.S. Congress or, if certain requirements are met, the Secretary of the Interior. Each river is administered by either a federal or state agency, including some rivers administered by the BLM.
- Wilderness Act of 1964 (16 U.S.C. 1131 et seq.)—Established the National Wilderness Preservation System, a national network of more than 800 federally designated wilderness areas. These wilderness areas are designated by the U.S. Congress and managed by the National Park Service, BLM, USFWS, and U.S. Forest Service (USFS).
- CAA (42 U.S.C. 7609)—The EPA reviews all draft EISs prepared by other federal agencies, as well as other certain federal actions, as required by Section 309 of the CAA. Section 309 also requires that EPA make these reviews public. The EPA does this by posting EPA comment letters on EISs in the EPA's EIS database (EPA 2023p).
- Fixing America's Surface Transportation (FAST) Act (42 U.S.C. 4370m et seq.)—Includes a voluntary program to help ensure a deliberate, transparent, and predictable federal environmental review and permitting process, along with long-term funding certainty, for certain large, complex infrastructure projects. The project portfolio consists primarily of renewable energy, coastal restoration, and electricity transmission projects.
- Energy Policy Act of 2005 (P.L. 109-58)—Provides tax incentives and loan guarantees administered by the DOE for energy production of various types, including solar, to encourage the electricity industry to build more renewable energy.
- Energy Independence and Security Act of 2007 (P.L. 110-140)—Seeks to expand the production of renewable fuels, reduce U.S. dependence on oil, increase energy security, and address climate change. Provisions of the act include establishing new standards for vehicle fuel economy, energy efficiency provisions for government and public institutions, and funding for accelerated research and development of renewable energies.
- Energy Act of 2020 (P.L, 116-260; 43 U.S.C. 3001 et seq.)—Among other provisions, requires the Secretary of the Interior to set national goals for wind, solar, and geothermal energy production on federal land. The act also directs the Secretary to seek to permit at least 25 GW of electricity from wind, solar, and geothermal projects by 2025. The law also established a national Renewable Energy Coordinator Office within the BLM. This office is responsible for

establishing and implementing a program to improve federal permit coordination with respect to eligible projects, including utility-scale solar energy development, on BLM-managed land.

3.3.1.2 Policies and Guidance

DOI

- *DOI Departmental Manual* (DM) Part 516, Chapter 1 (516 DM 1): Protection and Enhancement of Environmental Quality (DOI 2009a)—Instructions for implementing NEPA requirements and guidance for implementing the CEQ and DOI NEPA regulations. Must be read in conjunction with both sets of NEPA regulations (40 CFR Part 1500 et seq. and 43 CFR Part 46, respectively).
- 516 DM 2: Relationship to Decision Making (DOI 2009b)—Guidance for implementing those portions of the CEQ NEPA regulations (40 CFR Part 1500 et seq.) and the DOI's NEPA regulations (43 CFR Part 46) pertaining to decision making.
- 516 DM 3: Managing the NEPA Process (DOI 2009c)—Guidance for implementing the provisions of the CEQ NEPA regulations (40 CFR Part 1500 et seq.) and the DOI's NEPA regulations (43 CFR Part 46) that pertain to implementing and managing the NEPA process.
- 516 DM 11: Managing the NEPA Process—BLM (DOI 2020)—Guidance for implementing NEPA in accordance with 43 CFR Part 46 and departmental manuals within the BLM.
- DOI Environmental Memoranda for NEPA Compliance (DOI undated)—Guidance from DOI's Office of Environmental Policy and Compliance to DOI bureaus and offices to ensure compliance with various pollution control and environmental protection statutes through its Environmental Memoranda series, along with other guidance documents.

BLM[2]

- *National Environmental Policy Act: Handbook H-1790-1* (BLM 2008a)—Guidance for completing the environmental analyses required by NEPA, CEQ NEPA regulations, and the DOI's NEPA regulations.
- *Land Use Planning*: *Handbook H-1601-1* (BLM 2005a)—Guidance for preparing, amending, revising, maintaining, implementing, monitoring, and evaluating BLM-administered land use plans.
- *Mitigation: Handbook H-1794-1* (BLM 2016e) and *Mitigation: Manual MS-1794* (BLM 2016f)—Guidance on how to approach identifying, considering, and requiring mitigation to address impacts on resources from BLM-administered land uses.

[2] Note that while certain IMs/IBs listed in this section have expired, they continue to provide guidance that may be considered in the absence of superseding information.

- *Rent: Manual MS-2806 – Chapter 6. Rent and Fee Reductions for Solar and Wind Energy Development Authorizations* (BLM 2022)—Implements reduced acreage rent rates and MW capacity fees for existing and new wind and solar projects on public lands pursuant to the authority under the Energy Act of 2020 and which also support Section 207 of E.O. 14008.
- *Wildlife and Fisheries Management: Manual MS-6500* (BLM 1988)—Guidance for BLM's wildlife and fisheries program.
- *Fish, Wildlife, and Special Status Plant Resources Inventory and Monitoring: Manual MS-6600* (BLM 1990)—Guidance on inventory and monitoring of fish, wildlife, special status species, and plants to ensure full consideration in BLM decision and planning.
- *Aquatic Resource Management: Manual MS-6720* (BLM 1991)—Provides guidance and establishes the BLM's objectives and policy for invertebrates, fish, and wildlife that depend upon aquatic habitats.
- *Special Status Species Management: Manual MS-6840* (BLM 2008b)—Provides guidance and establishes policy for management of species listed or proposed for listing pursuant to the ESA and BLM sensitive species that are found on BLM-administered lands.
- IM-2023-015: Variance Process for Solar Energy Applications (BLM 2022a)—Guidance for assessing applications for solar energy development on BLM-administered lands allocated as variance areas under the BLM 2012 Western Solar Plan.
- IM-2023-005: "Habitat Connectivity on Public Lands" (BLM 2022k)—Directs BLM state offices to explicitly consider habitat connectivity, permeability, and resilience as a means to ensure self-sustaining populations. Its intent is to ensure habitat connectivity, permeability, and resilience is restored, maintained, improved, and conserved on public lands.
- IM-2022-027: "Initial Screening and Prioritization for Solar and Wind Energy Applications and Nominations/Expressions of Interests" (BLM 2022k)- clarifies initial screening measures and standardized prioritization methodologies for solar and wind right-of-way (ROW) grant applications and ROW lease nominations on public lands.
- IM-2021-038: "Rescinding IM No. 2019-018, Compensatory Mitigation Policy" (BLM 2021g)—Rescinded existing compensatory mitigation guidance determined to be inconsistent with presidential and secretarial policies on compensatory mitigation. States that BLM offices should consider and implement compensatory mitigation on a case-by-case basis until new policies are established.
- IM-2021-026: Use of Competitive Processes for Solar and Wind Energy Development Outside of Designated Leasing Areas (BLM 2021d)—Guidance on when the BLM may or may not use competitive processes to offer BLM-administered land for solar and wind energy development outside of DLAs.

Except as otherwise provided in the IM, the BLM should offer land outside a DLA through a competitive process only when the BLM determines that competitive interest exists.

- IM 2017-096: Acreage Rent and Megawatt Capacity Fees (Years 2016–2021) for Solar and Wind Energy ROW Grants and Leases (BLM 2017b)—Guidance on the implementation of the solar energy ROW acreage rent and MW capacity fee schedules pursuant to the final regulations at 43 CFR Part 2806. The BLM published a proposed rule on ROWs, leasing, and operations for renewable energy in the *Federal Register* on June 16, 2023, for public comment and review, which includes proposed changes to the BLM's acreage rent and capacity fee for solar and wind energy developments.
- IM 2019-013: National Policy for Rights-of-Way Bonding (BLM 2018b)—Guidance for requiring bonding determinations (required payments associated with BLM land use authorizations), and bonding where appropriate, on BLM ROW grants for authorized activities. Oil and gas leases, and solar/wind and geothermal energy leases, which are covered by other policies, do not require an Reclamation Cost Estimate or bond.
- IM 2017-099 – Technical and Financial Evaluations for Solar and Wind Energy Rights-of-Way Grants and Leases, issued September 14, 2017 (BLM 2017c)—Guidance on implementation of requirements to evaluate the technical and financial capabilities of an applicant or holder of a solar energy ROW grant or lease pursuant to the final regulations at 43 CFR Part 2800.
- IM 2017-040: BGEPA—Eagle Incidental Take Permit Guidance for Renewable Energy Development (BLM 2017d)—Guidance on processing ROW applications for wind and solar energy development projects that have the potential to result in eagle take. At the first preliminary application meeting for wind and solar energy proposals (including site and project area testing ROW applications), the BLM will inform applicants of potential eagle issues using information BLM has readily available. The USFWS is responsible for determining whether the proposed project is likely to result in take of eagles.
- IM 2011-181: Involvement of Grazing Permittee/Lessee with Solar and Wind Energy Right-of-Way Application Process (BLM 2011a)—Guidance to the BLM for addressing potential conflicts between solar energy applicants and potentially affected grazing permittee(s) and/or lessee(s) in allotment(s) that may be impacted by energy proposals. The IM clarifies 43 CFR Part 4110 (requirements for solar energy development applications that may affect livestock grazing operations) and addresses potential mitigation and compensation strategies and the relationship between energy application steps and/or decisions with grazing administrative steps and/or decisions.

Executive and Secretarial Orders

- E.O. 11988: Floodplain Management—Directs federal agencies to provide leadership and take action to reduce the risk of flood loss; to minimize the impact of floods on human safety, health, and welfare; and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities for (1) acquiring, managing, and disposing of federal lands and facilities; (2) providing federally undertaken, financed, or assisted construction and improvements; and (3) conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities.

- E.O. 11990: Protection of Wetlands—Directs federal agencies to provide leadership and take action to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities for (1) acquiring, managing, and disposing of federal lands and facilities; (2) providing federally undertaken, financed, or assisted construction and improvements; and (3) conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities.
- E.O. 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations—Directs federal agencies to identify and address the disproportionately high and adverse human health or environmental effects of their actions on minority and low-income populations, to the greatest extent practicable and permitted by law, and to develop a strategy for implementing EJ.
- E.O. 13007: Indian Sacred Sites—directs federal land managing agencies to accommodate access to, and ceremonial use of, Indian sacred sites by Indian religious practitioners and to avoid adversely affecting the physical integrity of such sacred sites.
- E.O, 13186: Migratory Bird Conservation - requires that each Federal agency taking actions that have, or are likely to have, a measurable negative effect on migratory bird populations develop and implement a MOU with the USFWS that promotes the conservation of migratory bird populations.
- E.O. 13175: Consultation and Coordination with Indian Tribal Governments—Requires federal agencies to have an accountable process to ensure meaningful and timely input by Tribal officials in the development of regulatory policies that have Tribal implications.
- E.O. 13212: Actions to Expedite Energy-Related Projects—Requires federal agencies to take appropriate actions, to the extent consistent with applicable law, to expedite projects that will increase the production, transmission, or conservation of energy.
- E.O. 13514: Federal Leadership in Environmental, Energy, and Economic Performance—Establishes "an integrated strategy towards sustainability in the Federal Government and [makes] reduction of greenhouse gas emissions (GHG) a priority for Federal agencies." Sets non-numerical targets that agencies must reach, including increasing renewable energy and renewable energy generation on agency property.

- E.O. 13783: Promoting Energy Independence and Economic Growth—Establishes a national policy to promote the clean and safe development of energy resources while reducing unnecessary regulatory burdens. Directs federal agencies to undertake several actions to further this goal.
- E.O. 13990: Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis—Highlights the need to use science to reduce GHG emissions, bolster resilience to the impacts of climate change, and prioritize EJ.
- E.O. 14008: Tackling the Climate Crisis at Home and Abroad—Requires federal agencies to implement a government-wide approach that reduces climate pollution in every sector of the economy; increases resilience to the impacts of climate change; protects public health; conserves our lands, waters, and biodiversity; delivers EJ; and spurs well-paying union jobs and economic growth, especially through innovation, commercialization, and deployment of clean energy technologies and infrastructure.
- E.O. 14096: Revitalizing Our Nation's Commitment to Environmental Justice for All—Requires federal agencies to advance EJ by implementing and enforcing the Nation's environmental and civil rights laws, preventing pollution, addressing climate change and its impacts, and working to clean up legacy pollution that is harming human health and the environment.
- DOI Secretarial Order 3285A1: Renewable Energy Development by the DOI (DOI 2010)—Establishes the renewable energy development of renewable energy as a DOI priority for the DOI. Establishes the Departmental Task Force on Energy and Climate Change.
- DOI Secretarial Order 3362: Improving Habitat Quality in Western Big-Game Winter Range and Migration Corridors—Requires that DOI agencies "Review and use the best available science to inform development of specific guidelines for the Department's lands and waters related to planning and developing energy, transmission, or other relevant projects to avoid or minimize potential negative impacts on wildlife."

Relevant BLM EISs, Plans, and Publications

- *Final Programmatic EIS for Geothermal Leasing in the Western United States* (BLM and USFS 2008)—Facilitates geothermal leasing decisions on existing and future lease applications and nominations on the federal mineral estate in the western United States.
- *Programmatic Environmental Impact Statement, Designation of Energy Corridors on Federal Land in the 11 Western States* (DOE and BLM 2008)—Responds to Section 368 of the Energy Policy Act of 2005, which requires, among other things, the designation of energy corridors on federal lands in 11 western states and the establishment of procedures to ensure that additional corridors are identified and designated as necessary and to expedite applications to construct or modify oil, gas, and hydrogen pipelines and electricity transmission and distribution facilities.

- *Energy Policy Act of 2005 Section 368 Energy Corridor Review, Final Report: Regions 1–6* (BLM et al. 2022)—Through a robust and collaborative multi-year review, identifies the existing west-wide (Section 368) energy corridors across federal lands in the western continental United States. The report was compiled from regional review reports and comments received to provide BLM and USFS decision makers with recommended revisions, deletions, and additions to the Section 368 energy corridors. The agencies examined the Section 368 energy corridors at a regional level with substantial input from Tribes, states, local governments, non-governmental organizations, conservation community groups, electric utilities, renewable energy developers, the oil and gas industry, wildlife organizations, advocacy groups, private landowners, and BLM and USFS staff.
- *Final Programmatic EIS on Wind Energy Development on BLM–Administered Lands in the Western United States* (BLM 2005b)—Assesses the environmental, social, and economic impacts associated with wind energy development on BLM-administered land. Evaluates alternatives to determine whether the proposed action is the best management approach for the BLM to adopt, in terms of mitigating potential impacts and facilitating wind energy development.
- *Final Programmatic Environmental Impact Statement: Vegetation Treatments Using Herbicides on Bureau of Land Management Lands in 17 Western States* (BLM 2007a)—Determines which herbicide active ingredients would be available for use on BLM-administered lands in the western United States, including Alaska, to improve the agency's ability to control hazardous fuels and unwanted vegetation. In addition to the herbicides currently approved for use, the BLM considered additional active ingredients in order to address emerging weed problems associated with BLM-administered lands, such as downy brome (cheatgrass) and invasive aquatic species. In consultation with the EPA, USFWS, and National Oceanic and Atmospheric Administration National Marine Fisheries Service, the EIS also develops a state-of-the-science human health and ecological risk assessment (ERA) methodology to serve as the initial standard for assessing human health and ecological risk for herbicides that may become available for use in the future.
- *Programmatic Environmental Impact Statement: Vegetation Treatments Using Aminopyralid, Fluroxypyr, and Rimsulfuron on Bureau of Land Management Lands in 17 Western States* (BLM 2016g)—Added aminopyralid, fluroxypyr, and rimsulfuron to the list of approved active ingredients for use on BLM-administered lands. These herbicides were selected based on their effectiveness at controlling invasive plant species and their suitability for the BLM's treatment needs.
- DRECP and EIS (BLM 2016h)—Focuses on 10.8 million acres of BLM-administered lands in the desert regions of seven California counties: Imperial, Inyo, Kern, Los Angeles, Riverside, San Bernardino, and San Diego. This landscape-level plan streamlines renewable energy development while providing for the conservation of unique and valuable desert ecosystems and for outdoor recreation opportunities. The DRECP is a collaborative effort between the

California Energy Commission, California Department of Fish and Wildlife, the BLM, and the USFWS, collectively known as the Renewable Energy Action Team.

- *Renewable Arizona: Restoration Design Energy Project (RDEP) and EIS*(BLM 2013a)—A BLM Arizona initiative to identify lands across the state that may be suitable for the development of renewable energy. The RDEP supports the Secretary of the Interior's goals to build America's new energy future and to protect and restore treasured landscapes. It identifies Renewable Energy Development Areas that include disturbed sites, and identifies a Solar Energy Zone (SEZ) for Arizona. Examples of disturbed sites include landfills, retired agricultural lands, and abandoned mines and lands with low resource sensitivity and few environmental conflicts.
- Other resource management plans within the 11-state planning area—Land use plans are planning and management documents that define how resources will be managed within a specific planning area, and they establish restrictions on activities to be undertaken in that planning area. The land use planning process is the key tool that the BLM uses to protect resources and designate uses on federal lands it manages. These plans help ensure that BLM-administered lands are managed in accordance with applicable laws and regulations under the principles of multiple use and sustained yield. The BLM develops land use plans in accordance with federal requirements and BLM regulations and planning policies. Depending on when a land use plan was written or last revised, it may exist as a Management Framework Plan, in the original format, or as a newer RMP. Land use plans are typically organized according to the resources present in the planning area. For each identified resource (e.g., wildlife, minerals, or recreation areas), the plan will identify management objectives and management actions. Often management actions establish restrictions or stipulations regarding the use or development of the given resource. Many resources are common to virtually all BLM planning areas, and the corresponding land use plans establish management actions to ensure appropriate resource management. Many of these are resources that might be affected by solar energy development projects: wildlife (including federally and state-protected species), wildlife habitat, soils, water resources, cultural and historic resources, visual resources, recreation areas, and forestry resources. In addition, many land use plans establish restrictions or stipulations specific to relevant management issues, such as hazardous materials management, fire management, and wild horse management. Due to the programmatic nature of this planning effort, stipulations and exclusions from individual land use plans in the 11-state planning area have not been specifically incorporated into the exclusions and design features presented. However, stipulations from the applicable land use plans will be taken into account in the course of considering individual applications for solar energy ROWs.

3.3.2 Processes and Guidance

3.3.2.1 BLM Process for Authorizing Solar Energy Development Rights of Way

Utility-scale solar energy facilities on BLM-administered lands may be authorized by a ROW under Title V of FLPMA and its implementing regulations at 43 CFR Part 2800.

Process for Issuing Solar Development ROW Grants

A general representation of the BLM's process for solar energy development ROW grants is illustrated in Figure 3.3.2-1.

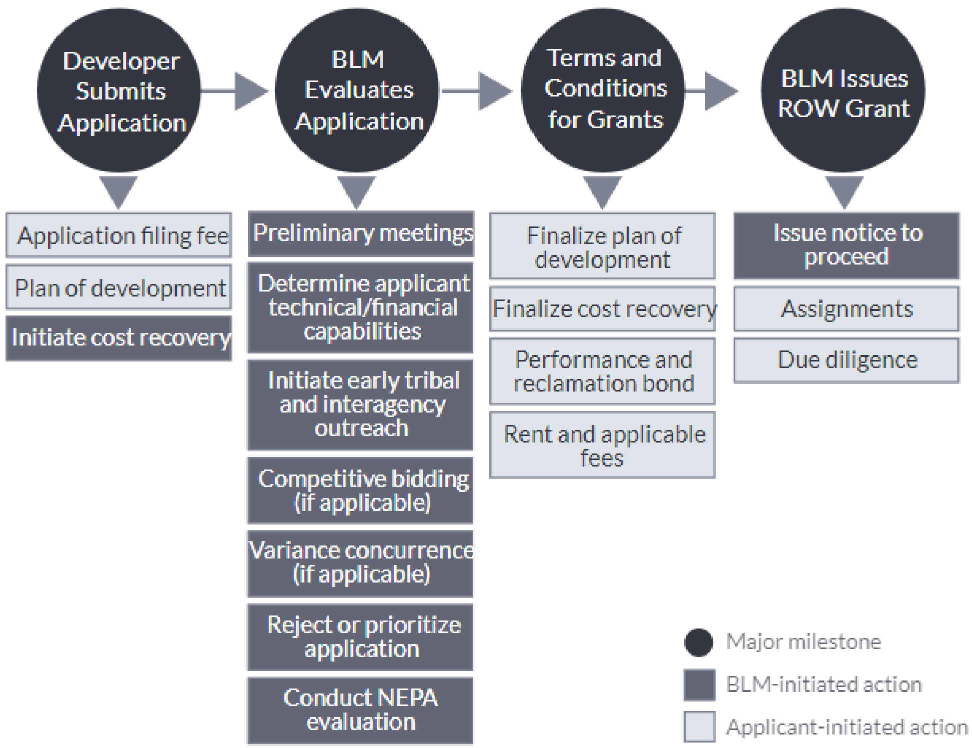


Figure 3-3.2-1. Process for Issuing Solar Energy ROW Grants

Process for Solar Energy Development ROW Leases

The regulations at 43 CFR Part 2800 allow the BLM to issue solar energy ROW leases (43 CFR Part 2809) through a competitive process for utility-scale solar energy development within DLAs. The BLM may include lands in a competitive offer on its own initiative, solicit nominations by publishing a call for nominations, or consider informal expressions of interest suggesting lands to be included in a competitive offer. The BLM will generally prioritize the processing of leases awarded under this subpart over the processing of non-competitive grant applications under 43 CFR Part 2804. A general representation of the BLM's process for solar energy development leases is illustrated in Figure 3.3.2-2.

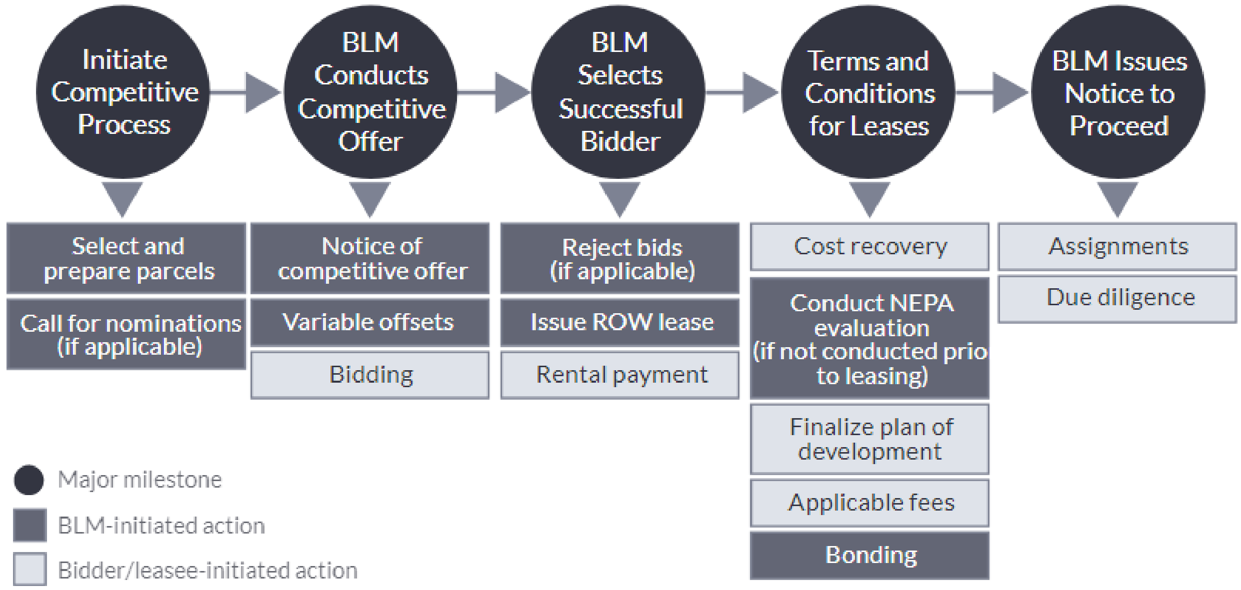


Figure 3.3.2-2. Procedure for Issuing Solar Energy ROW Leases

3.3.2.2 Existing BLM Mitigation Requirements for Solar Energy Development

Under the BLM's FLPMA ROW regulations at 43 CFR 2804.12, applicants for ROW grants or leases must "address all known potential resource conflicts with sensitive resources and values, including special designations or protections, and include applicant-proposed measures to avoid, minimize, and compensate for such resource conflicts, if any." Required mitigation measures have been identified through the Western Solar Plan ROD, the 2013 RDEP ROD (BLM 2013a), and the 2016 DRECP ROD (BLM 2016a). In addition, individual land use plans and project-specific NEPA documents may also develop mitigation measures and stipulations relevant for solar energy development.

The Western Solar Plan ROD also established a policy that Solar Regional Mitigation Strategies (SRMSs) would be developed for SEZs. The BLM finalized SRMSs for SEZs in Arizona and Colorado, and for the Dry Lake and Dry Lake Valley North SEZs in Nevada. In 2019, work on SRMS development stopped when IM-2019-018 established policy that compensatory mitigation could not be required as a condition for project approvals (BLM 2019d). However, with the issuance of IM 2021-038 (BLM 2021g), the BLM rescinded the previous IM-2019-018. Compensatory mitigation may be considered and implemented on a case-by-case basis, in consultation with BLM state office and national office program specialists and the Office of the Solicitor as needed.

The BLM's land use plans may establish restrictions or stipulations regarding the use or development of resources. In addition, many land use plans establish restrictions or stipulations specific to relevant issues, such as hazardous materials management, fire management, and solar energy development. Stipulations from the applicable land use plans will be taken into account in the course of considering individual applications for solar energy ROWs.

State wildlife agencies also follow laws, regulations, and guidelines for avoidance and mitigation of wildlife impacts (for example, the Nevada Conservation Credit System regulations for sage-grouse). State Wildlife Action Plans can be used as guidance to help avoid impacts on wildlife resources. In addition, State Heritage Data Management Systems are available to identify wildlife species status and distribution.

4 Affected Environment

Chapter 4 presents a general description of the existing conditions and trends of resources and resource uses in the planning area that may be affected by implementing any of the BLM's Action Alternatives. While the description in general covers the 11-state planning area, with respect to certain resources the discussion of the affected environment on BLM-administered lands (also known as public lands) requires additional focus. For instance, ecological resources are varied in their distribution, and some that occur in the planning area are not present on BLM-administered lands. The description of the affected environment in this chapter provides the basis for identifying potential impacts to support this Solar Programmatic EIS.

The BLM manages large acreages of diverse public lands within the planning area, with topography ranging from low deserts to high mountains. The land uses are as varied as the terrain and include a wide range of outdoor recreation activities; a variety of uses by Tribes including hunting, fishing, and ceremonial uses; livestock grazing; wildlife habitat; military aviation; oil, gas, and mineral exploration and development; and wind and solar energy development. These uses are managed within a framework of numerous public land laws, the most comprehensive of which is the FLPMA. The FLPMA establishes several fundamental policies regarding the management of public lands, including the policy directing lands to be managed "on the basis of multiple use and sustained yield unless otherwise specified by law." "Multiple use" means management so that "public lands and their various resource values […] are utilized in the combination that will best meet the present and future needs of the American people" (Section 103(c) of the FLPMA). "Sustained yield" means the achievement and maintenance in perpetuity of a high level or regular periodic output of the variable renewable resources of the public lands consistent with multiple use Section 103(h) of the FLPMA.

The uses to which public lands are dedicated and the allocation of those uses are identified in BLM-administered land use plans called a Resource Management Plan, or RMP. RMPs are periodically prepared and revised through an open process that encourages input from public land users and other interested individuals and groups regarding the mix of potential uses of public lands. The more than 150 land use plans covering the 11-state planning area could be affected by decisions related to the Programmatic EIS, and many are proposed for amendment to reflect those decisions (Appendix A).

The status of public lands in the 11-state planning area is constantly changing with the approval of new right-of-way (ROW) authorizations, land exchanges, withdrawals, and the implementation of RMP and management decisions. Future decisions could lead to substantial changes in land management—for example, decisions to change greater sage-grouse management areas. Figures in Section 2.1 show the BLM-administered lands proposed as available for solar energy development application under the alternatives in this Programmatic EIS. The exclusion areas and lands available for application would be updated over time to reflect new BLM decisions on land use allocations.

4.1 Acoustic Environment

This section provides general descriptions of noise and vibration and the existing acoustic environment in the 11-state planning area. Potential impacts of noise and vibration on humans and wildlife are discussed in sections 5.1 and 5.4.3, respectively.

4.1.1 Noise

Any pressure variation that the human ear can detect is considered sound; noise is unwanted sound. Sound is described in terms of amplitude (perceived as loudness) and frequency[1] (perceived as pitch). Sound pressure levels are typically measured with the logarithmic decibel (dB) scale. A-weighting (denoted by dBA) is widely used to account for human sensitivity to frequencies of sound (i.e., less sensitivity to lower and higher frequencies, and most sensitivity to sounds between 1 and 5 kHz), and is correlated with a human's subjective reaction to sound (Acoustical Society of America 1983, 1985). To account for variations of sound with time, the equivalent continuous sound level (L_{eq}) is used. L_{eq} is the continuous sound level during a specific time period that would contain the same total energy as the actual time-varying sound. For example, L_{eq} (1-h) is the 1-hour equivalent continuous sound level. In addition, human responses to noise differ depending on the time of day; humans experience more annoyance from noise during nighttime hours. The day-night average sound level (L_{dn}, or DNL) is the average noise level over a 24-hour period, after the addition of 10 dB to sound levels from 10 p.m. to 7 a.m. to account for the greater sensitivity of most people to nighttime noise. The Community Noise Equivalent Level (CNEL) was introduced in the early 1970s by the State of California and gives 5-dB weighting to evening hours (7 to 10 p.m.), whereas L_{dn} has no weighting. As a practical matter, the CNEL and L_{dn} are almost equivalent, usually differing by less than 1 dB, and thus they can be used interchangeably.

People's responses to changes in sound levels generally exhibit the following characteristics (NWCC 2002): except under laboratory conditions, a 1-dB change in sound level is not perceptible; a 3-dB change is generally considered a just-noticeable difference; and a 10-dB increase is subjectively perceived as a doubling in loudness and almost always causes an adverse community response.[2]

Several important factors that affect the propagation of sound in the outdoor environment are presented in Appendix F, Section F.1.2, along with descriptions of screening-level and refined noise analysis.

The Noise Control Act of 1972, along with its subsequent amendments (Quiet Communities Act of 1978, U.S.C. 42 4901–4918), delegates to the states the authority

[1] The unit of frequency is the hertz (Hz): one Hz is equal to one cycle per second and 1 kHz is the same as 1,000 Hz. For reference, The normal hearing frequency range of a healthy young person is about 20 Hz to 20,000 Hz (or 20 kHz).

[2] A 3-dB change yields a 100% increase or decrease in sound energy and just over a 23% increase or decrease in loudness. For example, a doubling of traffic or of numbers of equipment results in a 3-dB increase.

to regulate environmental noise and directs government agencies to comply with local community noise statutes and regulations.

Many local noise ordinances are qualitative, such as prohibiting excessive noise or noise that results in a public nuisance. Because of the subjective nature of such ordinances, they are often difficult to enforce. However, several states, counties, and/or cities have established quantitative noise-level, which are discussed in Appendix F, Section F.1.2.

The EPA has a noise guideline that recommends an L_{dn} of 55 dBA, which is sufficient to protect the public from the impact of broadband environmental noise in typical outdoor and residential areas (EPA 1974). These levels are not regulatory goals but are "intentionally conservative to protect the most sensitive portion of the American population" with "an additional margin of safety." For protection against hearing loss in the general population from non-impulsive noise, the EPA guideline recommends an L_{eq} of 70 dBA or less over a 40-year period.

As discussed, states, counties, and/or local governments adopt different noise metrics and criteria, so relevant noise regulations for the area where the site-specific solar project is planned should be applied along with EPA's noise guidelines.

Noise levels continuously vary with location and time. In general, noise levels are high around major transportation corridors (highways and railways), airports, industrial facilities, and construction activities. To provide noise levels associated with general community activities over the 11 western states, countywide L_{dn} levels are estimated based on population density, as presented in Appendix F, Section F.1.2.

4.1.2 Vibration

Construction activities can result in varying degrees of ground vibration, depending on the equipment and methods employed. Construction activities that typically generate the most severe vibrations are blasting and impact pile-driving.

Three ground-borne vibration impacts are of general concern: (1) human annoyance, (2) interference with vibration-sensitive activities, and (3) damage to buildings. In evaluating ground-borne vibration, two descriptors are widely used:

- The peak particle velocity, measured as a distance per time (such as in./s), is the maximum peak velocity of the vibration and correlates with the stresses experienced by buildings.
- The vibration velocity level (L_v) represents a 1-second average amplitude of the vibration velocity. It is typically expressed on a log scale in decibels (VdB) just as noise is measured in dB. This descriptor is suitable for evaluating human annoyance because the human body responds to average vibration amplitude.

In the United States, there are no widely adopted standards for acceptable levels of ground vibration generated by construction activities, although some jurisdictions elect to adopt vibration standards.

A background vibration velocity level in residential areas is usually 50 VdB or lower, well below the threshold of perception for humans, which is around 65 VdB (Quagliata et al. 2018). However, vibration levels would typically be higher in the immediate vicinity of transportation corridors or construction/demolition sites. Human response is not usually significant unless the vibration exceeds 70 VdB. For evaluating interference with vibration-sensitive activities, the vibration impact criterion for general assessment is 65 VdB. For residential and institutional land use (primarily daytime use only, such as a school or church), the criteria range from 72 to 80 VdB and from 75 to 83 VdB, respectively, depending on event frequency. For potential structural damage effects, guideline vibration damage criteria for various structural categories are provided in Quagliata et al. (2018). Damage to buildings, however, would occur at much higher levels (0.12 in./s or higher, or about 90 VdB or higher) than human annoyance and interference with vibration-sensitive activities.

4.2 Air Quality and Climate

4.2.1 Air Quality

4.2.1.1 Meteorology

Climate varies substantially across the 11-state planning area and is influenced by variations in elevation, latitude, topographic features, vegetative cover, proximity to large water bodies, and ocean currents. General meteorological conditions for each state, extracted from historic climatic information issued by the Western Regional Climate Center (WRCC), are briefly described, followed by a summary of percent of possible sunshine, temperature, precipitation, and wind patterns across the 11-state planning area in Appendix F, Section F.2.2.1.

A PV solar energy resource map based on global horizontal irradiance is shown in Figure 4.2-1 (Sengupta et al. 2018).[3]

4.2.1.2 Existing Emissions and Air Quality

This section provides general descriptions for existing emissions of criteria pollutants and volatile organic compounds (VOCs) and the following federally based air quality programs likely to affect activities associated with solar energy development considered in this Programmatic EIS:[4]

- National/State Ambient Air Quality Standards (NAAQS/SAAQS), and
- General Conformity.

[3] Sum of direct normal irradiance (DNI), diffuse horizontal irradiance (DHI), and ground-reflected radiation; however, because ground-reflected radiation is usually insignificant compared to direct and diffuse, for all practical purposes global radiation is said to be the sum of DNI and DHI only.

[4] VOCs are organic vapors in the air that can react with other substances, principally NO_x, to form ozone (O_3) in the presence of sunlight.

4.2.1.3 Existing Emissions

Table 4.2-1 lists statewide criteria pollutant and VOC emissions for the 11-state planning area for the year of 2020 (EPA 2023b). The data upon which the table is based represent 16 source categories, largely in five groups: point (e.g., electric power plants and large industrial facilities); nonpoint (too small in magnitude to report as point sources, e.g., residential heating and consumer solvent use); on road (e.g., passenger vehicles and trucks); nonroad (e.g., construction equipment, aircrafts, locomotives, marine vessels); and event sources (e.g., wildfires and prescribed burns). Since the 1990s, sulfur dioxide (SO_2) and nitrogen oxides (NO_x) emissions from power plants across the country have been reduced substantially due to implementation of various emission reduction programs. Because of its large population and attendant industrial activities, California generally has the highest emissions of all the criteria pollutants and VOCs combined, with the highest for NO_x, carbon monoxide (CO), and VOCs. The second largest emissions are from Oregon, whose emissions are comparable to those from California for all criteria pollutants and VOCs combined, and the highest for particulate matter (PM),[5] although Oregon's population is about one-tenth that of California. The western United States experienced a series of major wildfires in 2020, especially California and Oregon. The 2020 Oregon wildfire season was one of the most destructive on record in the state of Oregon, which considerably increased emissions of CO and particle pollution (i.e., PM_{10} and $PM_{2.5}$), along with VOC emissions, to some extent. Nevada generally has the lowest emissions among the 11 states. SO_2 emissions are the highest in New Mexico, mostly from petroleum and related industries.

[5] PM is dust, smoke, and other solid particles and liquid droplets in the air. The size of the particulate is important and is measured in micrometers (μm), for which a micrometer is 1 millionth of a meter (0.000039 in.). PM_{10} is PM with an aerodynamic diameter less than or equal to 10 μm, and $PM_{2.5}$ is PM with an aerodynamic diameter less than or equal to 2.5 μm. For comparison, the average human hair is about 70 μm in diameter.

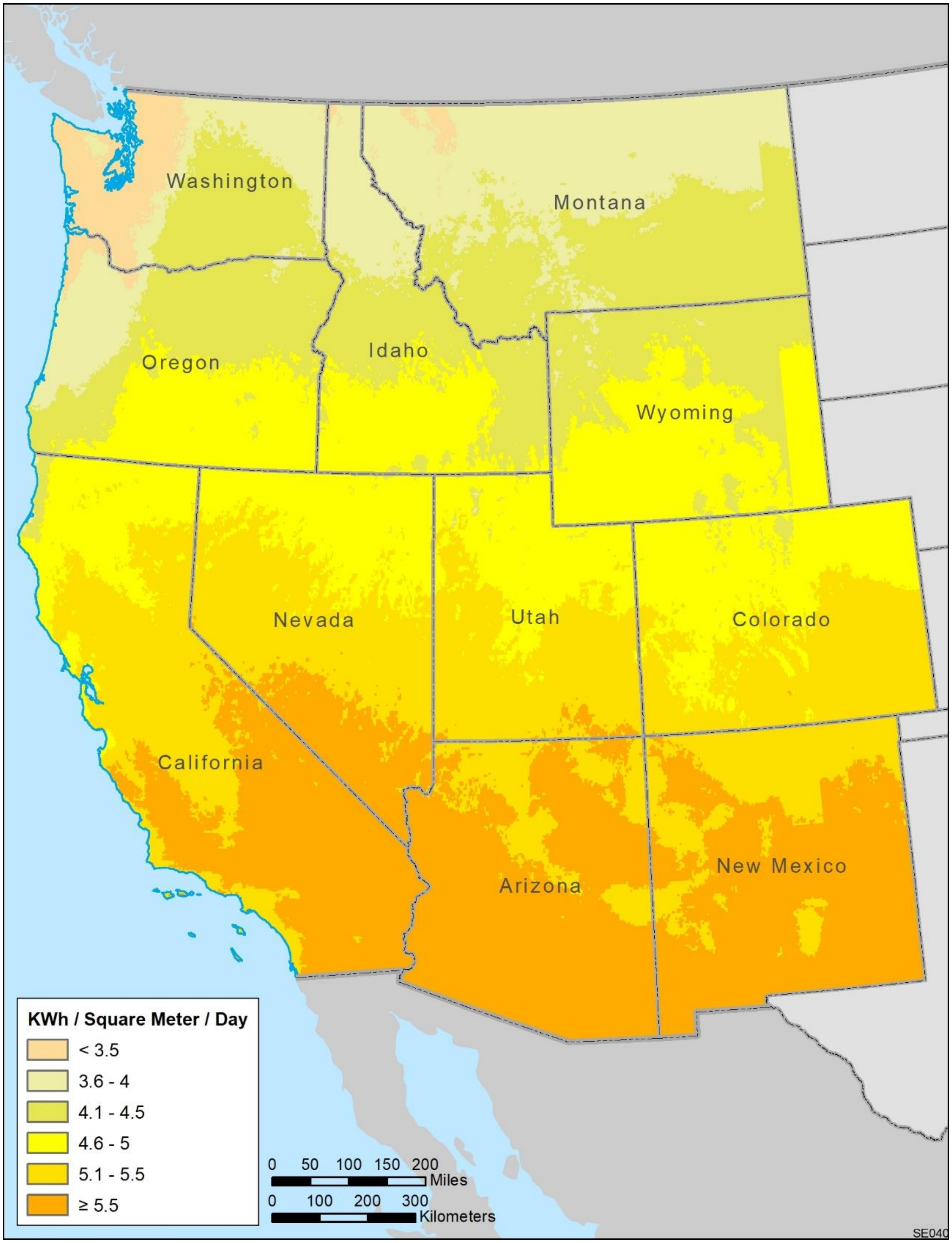


Figure 4.2-1. PV Solar Resources in 11 Western States (Source: Sengupta et al. 2018)

Table 4.2-1. Statewide Air Emissions for Criteria Pollutants and VOCs, 2020

State	Statewide Emissions (10^3 tons/yr)[a]					
	SO_2	NO_x	CO	VOCs	PM_{10}	$PM_{2.5}$
Arizona	17	136	1,196	260	184	81
California	70	481	8,425	2,120	1,123	708
Colorado	25	156	2,500	640	443	213
Idaho	8	59	1,000	253	433	120
Montana	13	71	646	179	453	108
Nevada	5	66	367	78	118	30
New Mexico	88	183	551	377	129	43
Oregon	54	173	7,979	1,854	1,273	712
Utah	13	98	818	234	184	68
Washington	13	162	1,348	305	189	107
Wyoming	39	99	592	196	402	87
Total	345	1,684	25,422	6,494	4,930	2,277

[a] To convert tons to metric tons, multiply by 0.907.
Source: EPA (2023b).

4.2.1.4 National and State Ambient Air Quality Standards

The EPA has set NAAQS for six criteria pollutants: SO_2, nitrogen dioxide (NO_2), CO, O_3, PM (PM_{10} and $PM_{2.5}$), and lead (Pb), as shown in Table F.14.2-2 (EPA 2023c). Primary NAAQS specify maximum ambient (outdoor air) concentration levels of the criteria pollutants with the aim of protecting public health with an adequate margin of safety. Secondary NAAQS specify maximum concentration levels with the aim of protecting public welfare. The NAAQS specify different averaging times as well as maximum concentrations. Some of the NAAQS for averaging times of 24 hours or less allow the standard values to be exceeded a limited number of times per year, and others specify other procedures for determining compliance. As shown in Table F.1.2-2, states can have their own SAAQS, which must be at least as stringent as the NAAQS and they can include standards for additional pollutants (as is done in California, Idaho, Montana, Nevada, New Mexico, and Oregon). If a state has no standard corresponding to one of the NAAQS, the NAAQS apply.

An area where a criteria pollutant concentration exceeds NAAQS levels is called a nonattainment area. Previous nonattainment areas where air quality has improved to meet the NAAQS are redesignated as maintenance areas and are subject to an air quality maintenance plan. Parts of the 11-state planning area have been in nonattainment for one or more of the NAAQS. Figure 4.2-2 shows these nonattainment areas for criteria pollutants (EPA 2023d). Currently, there are no nonattainment areas for CO and NO_2 in the United States. In descending order, 8-hour O_3, $PM_{2.5}$, and PM_{10} account for more nonattainment areas than any other criteria pollutants. More than half of counties in California are in nonattainment for 8-hour O_3, and many counties in California have nonattainment areas for $PM_{2.5}$ and PM_{10}. On the other hand, nonattainment areas for SO_2 and Pb are limited to a few counties in the 11-state planning area.

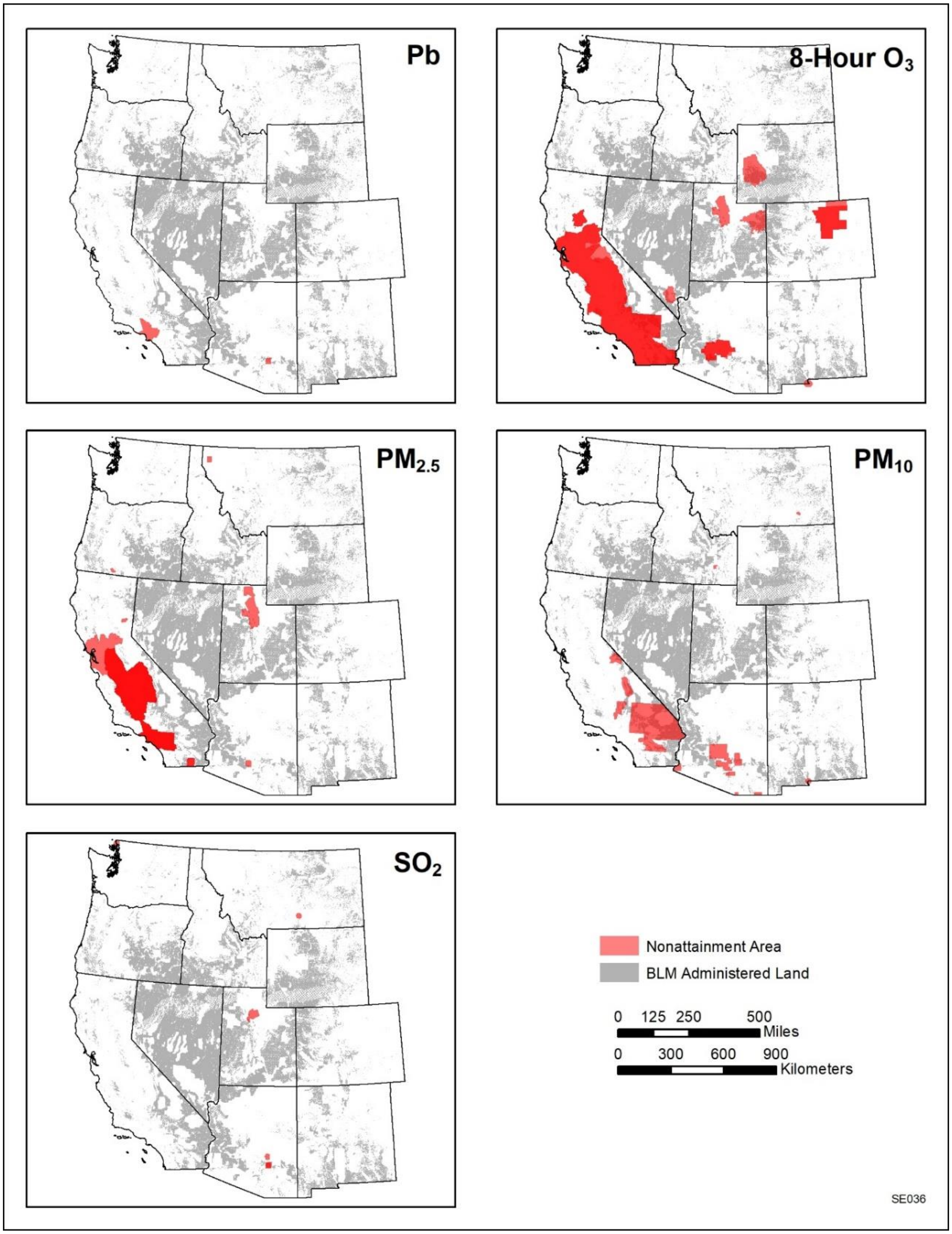


Figure 4.2-2. Nonattainment Areas for Pb, 8-hour O_3, $PM_{2.5}$, PM_{10}, and SO_2 in the 11-State Planning Area (there are no nonattainment areas for CO and NO_2 in the United States; source: EPA 2023d).

Prevention of Significant Deterioration (PSD) regulations applying to attainment or unclassified areas place limits on the total increase in ambient pollution levels above established baseline levels for SO_2, NO_2, PM_{10}, and $PM_{2.5}$, thus preventing "polluting up to the standard." In Federal PSD Class I areas, Federal Land Managers are responsible for protecting the air-quality-related values (AQRVs) of those areas, such as scenic, cultural, biological, and recreational resources. In general, utility-scale solar facilities are not considered a major stationary source subject to the PSD regulations because their air emissions are typically well below the major source emission threshold. Nevertheless, project developers should locate their projects not to deteriorate AQRVs of the Federal PSD Class I areas. Figure 4.2-3 shows the locations of federal PSD Class I areas over the 11-state study area.

4.2.1.5 General Conformity

Federal departments and agencies are prohibited from taking actions in nonattainment and maintenance areas unless they first demonstrate that the actions would conform to the SIP as it applies to criteria pollutants or their precursors (e.g., VOCs). Transportation-related projects are subject to requirements for transportation conformity. General conformity requirements apply to direct and indirect emissions from stationary, mobile, and area sources.[6] Conformity addresses only those criteria pollutants for which the area is in nonattainment or maintenance (e.g., VOCs and NO_x for O_3). If annual source emissions are below specified threshold levels, no conformity determination is required. If the emissions exceed the threshold, a conformity determination must be undertaken to demonstrate how the action will conform to the SIP. The demonstration process includes public notification and response and may require extensive analysis.

The EPA proposed new general conformity regulations on January 8, 2008 (73 FR 1402). The revised final rule was published on April 5, 2010 (75 FR 17254). The revised regulations improve the process federal agencies use to demonstrate how their actions will not interfere with the prevention and control of air pollution within states' and Tribes' nonattainment and maintenance areas for timely attainment of the NAAQS.

4.2.2 Climate

The greenhouse effect is a natural phenomenon occurring when certain gases (GHGs) absorb much of the long-wave thermal radiation emitted by the land and ocean and reradiate it back to earth, keeping the atmosphere warmer than it otherwise would be. Atmospheres, including water vapor and clouds, are also a major contributor to the greenhouse effect. Without the greenhouse effect, the earth would not be warm enough to support its existing biota. However, if the greenhouse effect becomes stronger, the earth's average temperature rises, resulting in global warming. Even a slight increase in temperature may cause problems for humans, plants, and animals. Global surface temperature has increased about by 1.8°F (1.0°C) from 1850–1900 to the first two decades of the 21st century (2001–2020) and by 2.0°F (1.1°C) to 2011–2020 (Arias et al. 2021). Global warming occurred in the distant past as a

[6] Direct emissions occur at the same time and place as the action and are reasonably foreseeable, while indirect emissions occur at a different time or place as the action but are still reasonably foreseeable.

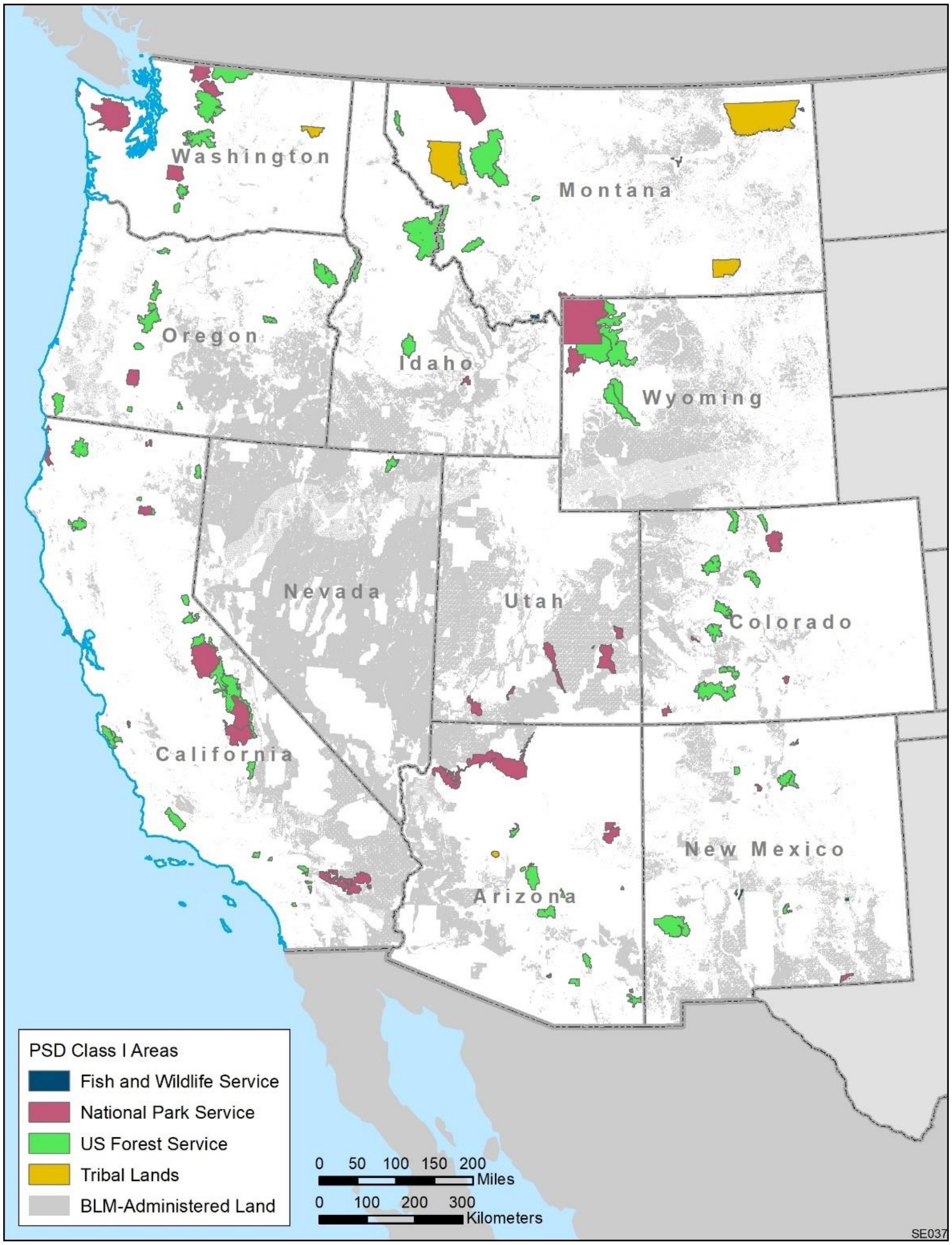


Figure 4.2-3. Federal PSD Class I Areas in the Eleven-State Study Area (Source: data from EPA 2015)

result of natural influences, but it is now occurring, especially since the Industrial Revolution, as a result of increased anthropogenic emissions of GHGs. For example, concentrations of carbon dioxide (CO_2), a primary GHG in the atmosphere, have continuously increased from approximately 280 ppm in preindustrial times to 421 ppm at Mauna Loa Observatory in March 2023, about a 50% increase (NOAA 2023a).

Because the global warming phenomenon is not distributed evenly across the Earth's surface, it is increasingly referred to as "global climate change." Climate change is a more flexible term than global warming, reflecting the fact that changes in the climate are not universal across the globe—some regions will warm, others will cool. Some of the critical climate changes already observed in the United States include increasing extreme weather conditions, such as heat waves, flooding, drought, high winds, thunderstorms, and hurricanes; sea level rise, high storm surge, and coastal flooding; shrinkage of glaciers and sea ice; earlier snowmelt and associated frequent wildfires; and ocean acidification, decreases in calcification on coral reefs and in some crustaceans and mollusks (USGCRP 2018).

4.2.2.1 Historic Climate Change by State

Climate change is happening globally and in the United States but the impacts can differ locally. In the past century, most of the 11-state planning area has warmed by 0.5–3.5°F (0.3–1.9°C) with the highest warming in coastal Southern California. Throughout the western United States, the decade from 2005 to 2015 was the warmest on record, with heat waves becoming more common and snow melting earlier in spring (EPA 2016a–k). This trend has continued through the present (NCEI 2022).

Rising temperatures also increase the rate at which water evaporates (or transpires) into the air from soils and plants. Evaporation increases as the atmosphere warms, which increases humidity, average rainfall, and the frequency of heavy rainstorms in many places—but contributes to drought in others. Unless rainfall increases to the same extent as evaporation, soils become drier. Throughout the West, much of the water needed for agriculture, public supplies, and other uses comes from mountain snowpack, which melts in spring and summer and runs off into rivers and fills reservoirs. However, as the climate warms, less precipitation falls as snow, and more snow melts during the winter. Changes in temperature and precipitation are affecting snowpack—the amount of snow that accumulates on the ground. In most of the West, snowpack has decreased since the 1950s, due to earlier melting and less precipitation falling as snow. Earlier snowmelt and prolonged drought, which cause the vegetation and soil to dry out, are likely to increase the severity, frequency, and extent of wildfires, which could harm property, livelihoods, and human health. Wildfire smoke can reduce air quality and increase medical visits for chest pains, respiratory problems, and heart problems. The size and number of western forest fires have increased substantially since 1985 (EPA 2016a–k); see also Section 4.21.

Appendix F, Section F.2.2.3 briefly summarize changes in temperature, precipitation, snowpack, and glaciers by planning area state.[7]

4.2.2.2 GHG Emissions

The GHGs include water vapor, O_3, CO_2, methane (CH_4), nitrous oxide (N_2O), and trace amounts of fluorinated gases, such as hydrofluorocarbons, perfluorocarbons (PFCs),

[7] Summary data for precipitation from NCEI (2022), and for temperature, snowpack, and glaciers from the EPA (2016a–k). Note that descriptions in EPA (2016a–k) and NCEI (2022), which are based on the data up to 2015 and 2020, respectively, can differ somewhat because the latter include more recent years that are the warmest period on record.

sulfur hexafluoride (SF_6), and nitrogen trifluoride. Along with clouds, water vapor (the most abundant GHG) accounts for the largest percentage of the greenhouse effect. However, water vapor concentrations fluctuate regionally, and human activity does not directly affect water vapor concentrations except at a local scale, such as near irrigated fields. Typically, water vapor is not included in climate change analyses. O_3, which is short-lived and spatially inhomogeneous in the atmosphere, is also not inventoried.

GHGs are emitted into the atmosphere through natural processes and human activities. CO_2 occurs naturally and also enters the atmosphere through the burning of fossil fuels, solid wastes, and trees and wood products, and also as a result of chemical reactions (EPA 2023e). CH_4 is emitted during the production and transport of fossil fuels and is also released to the environment as emissions from microbes, livestock, agricultural practices, and volcanoes. Natural emissions of N_2O primarily result from bacterial breakdown of nitrogen in soils and in the earth's oceans. N_2O is also emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste. Fluorinated gases are powerful GHGs that are emitted solely from various industrial activities.

The contribution of a given gas to the greenhouse effect is determined by both its abundance and its characteristics, such as the efficiency of the molecule as a GHG and its atmospheric lifetime. Global warming potential (GWP) is a relative measure of how much a given mass of a GHG is estimated to contribute to climate change compared with that of the same mass of CO_2. A GWP is calculated over a specific time interval. For example, CH_4 has a short lifetime of 11.8 years (Forster et al. 2021). CH_4 has a relatively high GWP (about 80) over a 20-year timescale, but has a GWP of 27–30 over a 100-year timescale, which the United Nations Framework Convention on Climate Change reporting guidelines require. Over the 100-year time horizon, N_2O has a GWP of 273. Some GWPs, such as fluorinated gases, are emitted in smaller quantities relative to CO_2, but have high GWPs; SF_6 has the highest GWP: 24,300. In general, GHG emissions are inventoried for CO_2, CH_4, N_2O, and high-GWP fluorinated gases in units of either metric tons of CO_2 equivalent ($MTCO_2e$) or million metric tons of CO_2 equivalent ($MMTCO_2e$), which weight each gas by its GWP (e.g., 27–30 for CH_4).

Gross GHG emissions by state for the year 2020 are shown in Table 4.2-2 (EPA 2023f).[8] Total emissions of 1,071.4 $MMTCO_2e$ for 11 states combined is about 18% of 2020 total United States GHG emissions (EPA 2023e). California is the largest contributor to GHG emissions, representing more than one-third of 11-state total emissions because of its population and attendant industrial and human activities. Colorado is the second contributor, accounting for about 11% of the total. In contrast, Idaho has the lowest GHG emissions, about 3% of the total. CO_2 is the primary GHG emitted through human activities, which accounts for about 74% of the 11-state totals, followed by CH_4 (about 14%) and N_2O (about 8%), and the fluorinated gases (about 3%).

[8] The gross emissions total presented exclude emissions and removals from Land Use, Land-Use Change, and Forestry (LULUCF), except the total CH_4 and N_2O emissions include LULUCF sector related emissions.

Table 4.2-2. Gross GHG Emissions by State, 2020

State	Emissions ($MMTCO_2e$/yr)	% of 11-State Total Emissions
Arizona	97.6	9.1
California	376.5	35.1
Colorado	116.3	10.9
Idaho	34.2	3.2
Montana	49.4	4.6
Nevada	42.2	3.9
New Mexico	73.6	6.9
Oregon	49.9	4.7
Utah	71.4	6.7
Washington	81.1	7.6
Wyoming	79.2	7.4
Total	1,071.4	100

Source: EPA (2023f).

U.S. GHG emissions have gradually increased since the Industrial Revolution, plateaued in 2004–2007 with a peak in 2007, and then slowly decreased to 2021 (EPA 2023e). GHG emission totals for the 11 states combined showed a trend similar to those for the United States, with a peak in 2007. However, the year in which the peak of emissions occurred varies slightly from state to state, mostly ranging from 2005 to 2008, except for Washington (where emissions peaked in 1999) and Idaho (where emissions peaked in 2019).

Because CO_2 is widely emitted worldwide, uniformly mixed throughout the troposphere, and stable, its climatic impact does not depend on the geographic location of sources; that is, the global total is the important factor with respect to climate change. Therefore, a comparison between United States and global emissions and the total emissions from the 11-state planning area is useful in understanding whether CO_2 emissions are significant with respect to climate change. Existing total CO_2 emissions of 818.5 $MMTCO_2$ from the 11-state planning area would be about 17.4% of 2020 total U.S. CO_2 emissions of 4,714.6 $MMTCO_2$ (EPA 2023e,f). In 2020, CO_2 emissions in the United States were about 15% of worldwide emissions of about 31,500 $MMTCO_2$ (IEA 2021a); current emissions for the 11-state planning area were about 2.6% of global emissions.

The Greenhouse Gas Reporting Program (GHGRP), codified at 40 CFR Part 98, requires reporting of GHG data and other relevant information from large GHG emission sources, fuel and industrial gas suppliers, and CO_2 injection sites in the United States (EPA 2023g). This data can be used by businesses and others to track and compare facilities' GHG emissions, identify opportunities to cut pollution, minimize wasted energy, and save money. States, cities, and other communities can use the EPA's GHG data to find high-emitting facilities in their area, compare emissions between similar facilities, and develop climate policies. A total of 41 categories of emission sources are covered by the GHGRP. Facilities determine whether they are required to report based on the types of industrial operations located at the facility, their emission levels, or other factors. Facilities are generally required to submit annual reports under 40 CFR Part 98 if (1) GHG emissions from covered sources exceed 25,000 $MTCO_2e$ per year or (2) supply of certain products would result in over 25,000 $MTCO_2e$ of GHG emissions if those products were released, combusted, or oxidized.

4.3 Cultural Resources

Cultural resources include archaeological sites and historic structures and features that are addressed under the National Historic Preservation Act (NHPA), as amended (P.L. 89-665). Cultural resources also include traditional cultural properties (TCPs), that is, properties that are important to communities' practices and beliefs and that are necessary for maintaining the community's cultural identity. Cultural resources refer to both man-made and natural physical features associated with human activity and, in most cases, are finite, unique, fragile, and nonrenewable. Cultural resources that meet the eligibility criteria for listing in the NRHP are formally referred to as historic properties (see Appendix F, Table F.3.2-1). Federal agencies must take into consideration the impacts on historic properties from undertakings under their direct or indirect jurisdiction before they approve expenditures or issue permits, ROWs, or other land use authorizations.

Federal agencies are also required to consider the impacts of their actions on sites, areas, and other resources (e.g., plants) that are of religious significance to Native Americans as established under the American Indian Religious Freedom Act (P.L. 95-341). Archaeological sites on public lands and Indian lands are protected by the Archaeological Resources Protection Act of 1979, as amended (P.L. 96–95). Native American human remains, funerary objects, sacred objects, and items of cultural patrimony are protected by the Native American Graves Protection and Repatriation Act of 1990 (P.L. 101-601). Cultural resources on federal lands are protected by laws penalizing the theft or degradation of property of the U.S. government (Theft of Government Property [62 Stat. 764, 18 U.S.C. 1361] and FLPMA). A list of these and other regulatory requirements pertaining to cultural properties is presented in Appendix F, Table F.3.—-1. These laws are applicable to any project undertaken on federal land or requiring federal permitting or funding.

Cultural resources on BLM-administered land are managed primarily through the laws identified in Table F.3.2-1. As required by implementing regulations of Section 106 of the NHPA at 36 CFR Part 800, BLM offices work with consulting parties to identify and evaluate historic properties and other cultural resources that may be affected by a proposed undertaking. The BLM has established a cultural resource management program as identified in its 8100 series manuals and handbooks (see Table F.3.2-2).

The goal of the program is to identify, evaluate, manage, and protect cultural resources on or within BLM-administered lands. Some lands containing significant cultural resources have been identified as ACECs (see Section 4.16, Specially Designated Areas and Lands with Wilderness Characteristics). ACECs are designated areas managed by the BLM that protect important cultural and scenic values as well as wildlife and other natural resources. ACECs designated specifically to protect cultural resources located near BLM-administered lands that are considered suitable for solar energy development are presented in Table F.3.2-3.

Guidance on how to apply the NRHP criteria to evaluate the eligibility of cultural resources located on BLM-administered lands is provided in numerous documents prepared by the NPS and in the BLM 8100 series manuals and handbooks. Further guidance on the application of cultural resource laws and regulations is provided through the BLM National Programmatic Agreement (2012l) developed among the BLM, the National Council of State Historic Preservation Officers, and the Advisory Council on Historic Preservation (ACHP), and implemented through state-specific protocols with each SHPO for the management of cultural resources programs and the review of projects pursuant to Section 106 of the NHPA.

Although site-specific information regarding cultural resources would need to be collected to define the affected environment of an individual project, the types of cultural resources listed on or eligible for listing in the NRHP in the broad 11-state planning area for this Programmatic EIS include, but are not limited to, sites, districts, buildings, structures, and objects. Areas considered cultural landscapes may also be present. These property types can take the form of artifact scatters, habitation areas, dwellings, temporary camps, collecting areas, and lithic processing areas. They may also include cultural resources attributed to historic exploration, ranching, mining, resource development and transportation. Locations of current use or of special significance can be identified as National Monuments, National Historic Landmarks, National Historic Trails, TCPs, and sacred sites.

TCPs and other areas of concern to various cultural groups, including Native American Tribes, can include a wide range of tangible and intangible resources (e.g., archaeological sites, funerary objects, places of religious ceremony, medicinal plants, and sacred landscapes). Government-to-Government consultation, in addition to Section 106 consultation, provides a means of identifying the affected environment for a particular site-specific project for sovereign nations. The public scoping and comment processes are avenues for other distinct cultural groups to make their concerns known regarding TCPs. It is difficult, if not impossible, to place hard boundaries on locations of traditional significance. Where boundaries might be defined, members of the cultural group may not be willing to disclose such information for a variety of reasons. Types of valued traditional resources may include, but are not limited to, archaeological sites, burial sites, religious sites, traditional harvest areas, trails, certain prominent geological features that may have spiritual significance (i.e., cultural landscapes), and viewsheds of sacred sites (including all of the above).

4.3.1 Cultural Resources including Archaeological and Historic Resources

While much can be learned through archaeological and historical research, how and what we learn about the past is constantly changing. Today we are learning more and more about Tribal cultures through traditional cultural knowledge shared during Tribal consultations. However, many of the frameworks we use for understanding how North

America was settled prior to the arrival of Europeans have been developed over time through archeological and ethnographic research. The history of Native Americans in the West has been commonly approached by dividing the American West into culture areas (see Figure F.3.2-1). These areas generally correspond to the major physiographic regions of the American West. The Native groups in a given culture area had to adapt to the regional climate and environment in order to survive. As a result, there are certain shared ways of life that characterize each region. Though there may be overlap in cultural practices, each Tribe is unique and shall be treated as such through formal consultation. Table F.3.2-4 summarizes the major precontact periods and the types of cultural resources associated with each culture area. The cultural resource types presented in Table F.3.2-5 represent the most common remains associated with each time period, not the total range of cultural resources associated with each time period. Historic period cultural resources occur across the 11-state planning area. As with the precontact periods, Euro-American settlement and use of the West also can be understood through adaptation to the culture areas that loosely correspond to the major physiographic regions of the West. While considerable overlap exists in the general types of cultural resources that are found in the West, there also is considerable regional variability. Table F.3-5 lists the culture areas and historic era cultural resource types by state. Again, this list of cultural resource types is not comprehensive; instead, it is intended to provide the most common property types. Figure F.3.2-1 also shows the locations of historic trails in addition to the culture areas. Within BLM-administered lands, thousands of cultural resource surveys have been conducted either for specific projects or for NHPA Section 110 requirements to inventory resources on federal lands. Table F.3.2-7 lists the number of acres surveyed on BLM-administered lands within the 11-state planning area by survey type and the number of cultural resources recorded since 1970.

4.3.2 *National Register* and Congressionally Designated Properties

Pursuant to the requirements within the NHPA, the BLM has made eligibility determinations on many cultural resources within lands they administer. Through this process, BLM has determined that certain NRHP-eligible cultural resources possess sufficient significance at the National level to be given National Historic Landmark status by the Secretary of the Interior. A complete list of National Historic Landmarks within the 11-state planning area is included in Table F.3.2-8 and shown in Figure F.3.2-1 (note that not all NHLs listed in the table are visible in Figure F.3.2-1). Congressionally designated NHTs are listed in Table F.3.2- 9 and shown on Figure F.3.2-1. Congressionally designated National Monuments form another class of protected areas on Federal lands. A list of National Monuments within the 11-state planning area is shown in Table F.3.2-10 in Appendix F.

4.3.3 Traditional Cultural Properties (TCPs)

TCPs are historic properties that are important to a community's practices and beliefs and that are necessary for maintaining the community's cultural identity. Locations of specific TCPs within the BLM-administered lands considered suitable for solar energy development are not currently available but are part of the ongoing discussions during Government-to-Government consultations with federally recognized Tribes and local communities and through the public comment process for all cultural groups (also see Section 4.18, Tribal Interests).

4.4 Ecological Resources

4.4.1 Vegetation

Plant communities occurring within the 11-state planning area span a great variety of ecosystems, from arid deserts to coastal coniferous forests. Each plant community is unique in species composition, richness, diversity, and structure. Several environmental factors, including climate, elevation, aspect (i.e., compass direction of slope), precipitation, and soil type, influence the presence and development of various types of plant communities throughout the planning area.

Because of the great variety and complexity of the plant communities occurring within the 11 states, the area is best represented by description at the “ecoregion” level. The concept of ecoregions is intended to provide a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components (EPA 2022a). An ecoregion is an area having a general similarity in ecosystems and is characterized by the spatial patterning and composition of biotic and abiotic features, including vegetation, wildlife, geology, physiography (patterns of terrain or land forms), climate, soils, land use, and hydrology, such that within an ecoregion, there is a similarity in the type, quality, and quantity of environmental resources present (EPA 2022a). Ecoregions of North America have been mapped in a hierarchy of four levels, with Level I being the broadest classification. Each level consists of subdivisions of the previous (next highest) level. The ecoregion discussions presented in this Programmatic EIS follow the Level III ecoregion classification, with 35 ecoregions covering the 11-state planning area (see Appendix E, Figure E-1 and Appendix F, Table F.4.1.2-1). These ecoregions are based on Omernik (1987) and refined through collaborations among EPA regional offices, state resource management agencies, and other federal agencies (EPA 2022b).

The 35 ecoregions in the 11 states include a wide variety of upland plant community types, such as coniferous forest, coniferous and deciduous woodland, shrub communities, shrub steppe, and grassland. Mountain ranges often support coniferous forest and woodlands, such as the ponderosa pine (*Pinus ponderosa*) habitats and pinyon-juniper (*Pinus* sp.-*Juniperus* sp.) woodlands found in many of the ecoregions, or mixed habitats such as the oak-juniper (*Quercus* sp.-*Juniperus* sp.) woodlands of the Chihuahuan Deserts and Madrean Archipelago ecoregions. The Cascades have a moist, temperate climate that supports fir (*Abies* sp.), Douglas fir (*Pseudotsuga menziesii*), and bigleaf maple (*Acer macrophyllum*). The Blue Mountains ecoregion is a diverse complex of mountain ranges, valleys, and plateaus containing deep rocky-walled canyons, glacially cut gorges, sagebrush steppe, juniper woodlands, mountain lakes, forests, and meadows. It also contains some of the largest intact native grasslands in Oregon

(BLM 2012c), dominated by perennial bunchgrass species such as Idaho fescue (*Festuca idahoensis*) (ODFW 2016).

Numerous basins occur in the planning area and often support shrublands, such as Great Basin sagebrush (*Artemisia* sp.), saltbush-greasewood (*Atriplex* sp., *Sarcobatus vermiculatus*), creosotebush (*Larrea tridentata*), or palo verde (*Cercidium* sp.) cactus shrublands. Basins in the region are mostly arid and include the Chihuahuan, Mojave, Sonoran and Great Basin Deserts. Large areas of palo verde-cactus shrublands with giant saguaro cactus (*Carnegiea gigantea*), along with long-lived ironwood (*Olneya tesota),* are in the Sonoran Basin and Range ecosystem. The Wyoming Basin ecoregion encompasses mountains and foothills dominated by stands of quaking aspen (*Populus tremuloides*) and five needle pine forests and woodlands (*Pinus flexilis* and *Pinus albicaulis*) (Carr and Melchor 2017).

Habitats on plateaus may include woodland, shrubland, or grassland. The Arizona/New Mexico Plateau ecoregion, for example, supports shrublands of big sagebrush (*Artemisia tridentata*), rabbitbrush (*Chrysothamnus* sp.),4-18verall4-18tt (Krascheninnikovia *lanata*), shadscale saltbush (*Atriplex confertifolia*), and greasewood, and grasslands of blue grama (*Bouteloua gracilis*), western wheatgrass (*P*ascopyrum *smithii*), green needlegrass (*Nassella viridula*), and needle-and-thread grass (*Hesperostipa comata*). Shrublands and pinyon-juniper woodlands are common in the Colorado Plateaus ecoregion.

Native grasslands dominated the plains that are now used mostly for cattle grazing and agriculture, such as wheat (*Triticum aestivum*) and alfalfa (*Medicago sativa*).

Originally, the Willamette Valley was covered by prairies, oak savannas, coniferous forests, extensive wetlands, and deciduous riparian forests. Today it is one of the most productive agricultural areas in Oregon. The Snake River Plain is gently sloping and with water available for irrigation, a large portion of the alluvial valleys also support agriculture. The intermontane valleys of the Wyoming Basin ecoregion are grass- and/or shrub-covered (EPA 2013).

Wetlands occurring within these ecoregions are extremely varied and include such wetland types as marshes, bogs, vernal pools, wet meadows, and forested wetlands. The recent U.S. Supreme Court decision in the case of *Sackett v. Environmental Protection Agency et al.* has resulted in a new definition of "waters of the United States," where adjacent wetlands would only be included if there is a continuous surface connection between them and the adjacent streams, oceans, rivers, and lakes (*Sackett v. EPA et al.* 2023). Pending current litigation, two different interpretations are now being used within the 11 states, with four of them (Idaho, Montana, Utah, Wyoming) using the pre-2015 regulatory regime (EPA 2023h).

The Northwestern Glaciated Plains of Montana contain a moderately high concentration of semi-permanent and seasonal wetlands, locally referred to as Prairie Potholes (EPA 2013). Wetland areas are typically inundated or have saturated soils for a portion of the growing season and support plant communities that are adapted to saturated soil conditions. Streambeds, mudflats, gravel beaches, and rocky shores are wetland areas that may not be vegetated (Cowardin et al. 1979). While surface flows provide the water source for some wetlands, others, such as springs and seeps, are supported by shallow groundwater levels and groundwater discharge. Wetlands are often associated with perennial water sources, such as springs, perennial segments of streams, or lakes and ponds. However, some wetlands, such as vernal pools, have seasonal or intermittent sources of water. The total wetland areas present on BLM-administered lands within each of the 11 states, based on the National Wetland Inventory, range from about 10,039 acres (41 km^2) in Washington to 1,780,041 acres (7,204 km^2) in Nevada (Table 4.4-1). These estimates represent 6% or less of the total surface area of BLM-administered land in each of the six states and less than 2% of the total surface area of BLM-Administered land for five of the states. Annual wetland losses have since decreased nationally compared with pre-1980s levels (Dahl 2006). While freshwater wetlands showed a slight overall gain in total area in prior years, vegetated freshwater wetlands continued to show losses (Dahl 2006). The U.S. Fish and Wildlife Service (USFWS) is due to publish the sixth *Status and Trends of Wetlands in the Conterminous United States* report, providing information on wetland gains and losses for the years 2009 to 2019, to Congress in 2023 (USFWS undated).

Table 4.4-1. Wetland Areas on BLM-Administered Land in the 11-State Planning Area

State	Wetlands on BLM-Administered Land (acres)[a]	Total BLM Area (acres)	BLM-Administered Land That Is Wetlands (%)
Arizona	209,537	12,109,387	1.7
California[b]	96,127	4,150,345	2.3
Colorado	115,860	8,354,288	1.4
Idaho	127,643	11,774,830	1.1
Montana	189,751	8,043,025	2.4
Nevada	1,780,041	47,272,715	3.8
New Mexico	164,643	13,493,083	1.2
Oregon	391,224	15,718,196	2.5
Utah	1,171,994	22,767,895	5.1
Washington	10,039	437,237	2.3
Wyoming	250,745	18,047,487	1.4

Source: USFWS (2022a).

[a] To convert from acres to km^2, multiply by 0.004047.

[b] Does not include lands within the DRECP.

Riparian vegetation communities occur along rivers, perennial and intermittent streams, lakes, and reservoirs, and at springs. These communities generally form a vegetation zone along the margin that is distinct from the adjacent upland area in species composition and density and may be emergent marsh, scrub-shrub, or forest communities. Riparian communities are dependent on streamflows or reservoir levels and are strongly influenced by the hydrologic regime, which affects the frequency, depth, and duration of flooding or soil saturation. Riparian communities may include wetlands; however, the upper margins of riparian zones may be only infrequently inundated. Riparian and wetland areas are valued because of the important services they provide within the landscape, such as providing fish and wildlife habitat, maintaining water quality, and flood control.

The composition and distribution of plant communities within ecoregions are influenced by several factors including, but not limited to, climate change, insects, diseases, grazing by wildlife and domestic livestock, and water management practices. Prior to European settlement, fires were the major disturbance on the landscape, set by lightning and Native Americans. Fire suppression after settlement by Europeans resulted in significant changes in vegetation, particularly in plant succession where previous frequent fires controlled the growth of woody vegetation (Gruell 1983).

In addition to fire suppression after European settlement, the introduction of non-native plants further changed community composition. Within non-native plant species, invasive species further threaten native habitats. E.O. 13112 defines invasive species as "an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health" (E.O. 13112). In a 2014 inventory compiled by field offices within BLM, the states with the largest infestations of invasive species were Nevada, Oregon, Utah, and Idaho. Annual grasses were the most prevalent and represented 70% of those infested areas (BLM 2016i).

BLM has adopted a landscape approach to natural resource management, using a set of concepts and principles when multiple stakeholders are involved to help achieve sustainable social, environmental, and economic outcomes. A multiscale index of landscape intactness provides a standardized approach to natural resource status and condition. Further discussion of current vegetation conditions and landscape intactness is presented in Appendix E.

4.4.2 Aquatic Biota

Within the 11-state planning area, the BLM administers lands containing a variety of freshwater aquatic habitats, which in turn support a wide diversity of aquatic biota. Aquatic habitats on these lands range from isolated desert springs in the southwestern portion that support unique and endemic fish species such as pupfish (family *Cyprinodontidae);* cold- and coolwater portions of the Columbia, Colorado, Green, and Snake River watersheds that support trout fisheries; warmwater and desert streams that are dominated by a variety of warmwater species; and coastal rivers of California, Oregon, and Washington that support anadromous salmon. Sport fish throughout the 11-state planning area include trout and salmon (family *Salmonidae)*, sturgeon (family *Acipenseridae),* catfish (family *Ictaluridae),* sunfish and black basses (family *Centrarchidae)*, suckers (family *Catostomidae),* perch and walleye (family *Percidae),* and pike (family *Esocidae).* Nonsport fish include numerous species of minnows (family *Cyprinidae)* and other species. In addition to fish, aquatic habitats also support a large variety of aquatic invertebrates, including mollusks, crustaceans, and insects that serve as a food base for fish and other vertebrate species. Vegetation associated with riparian and wetland habitats are described in Section 4.4.1, and semi-aquatic wildlife associated with riparian habitats, including amphibians, reptiles, and birds are discussed in Section 4.4.3. Section 4.4.4 summarizes the occurrence of special status species (e.g., species federally listed as threatened or endangered) or designated critical habitat that could occur in the 11-state planning area.

Non-native species can harm populations of native species through habitat alterations, predation, or competition. Within the 11-state planning area, numerous non-native aquatic species have been introduced in some regions, including invertebrates (e.g., zebra and quagga mussels, New Zealand mudsnails, and several crayfish species) and fishes (e.g., mosquitofish). In some cases, non-native species of fish have been intentionally or unintentionally established from other areas of the United States, where they are considered native.

Descriptions of the hydrologic regions within the 11-state planning area are provided in Section 4.20.1 and the locations of each of the regions is indicated in Figure 4.20-1. The following sections provide a general description of freshwater aquatic organisms and habitats grouped according to the major U.S. Geological Survey (USGS) water resource regions. Data regarding assemblages of macroinvertebrates and fish present in aquatic habitats on specific BLM lands are collected and maintained by BLM under their AIM Strategy (BLM 2023c). Although fish assemblages within the various hydrologic regions are described as typically coldwater or warmwater species, it should be noted that the distinction is somewhat arbitrary and that both adult and juvenile fish often move among various habitats on a seasonal basis to achieve favorable growth and survival conditions (Muhlfeld 2021; Armstrong et al. 2021). As a consequence, maintaining connectivity among aquatic habitats is an important concern.

4.4.2.1 Pacific Northwest Hydrologic Region

The Pacific Northwest hydrologic region encompasses the State of Washington, nearly all of Idaho and Oregon, and small portions of California, Montana, Nevada, Utah, and Wyoming (Figure 4.20-1). Streams, rivers, and lakes of the Pacific Northwest support numerous fish species, many of which are classified as game fish by the States' fisheries agencies within this region (USFS 2023a; IDFG 2023a; Zaroban et al. 1999). Game fish in this region include native coldwater fish species, especially salmonids and sturgeon, as well as warmwater fish, such as smallmouth bass and catfish, that are largely introduced from Midwest and Eastern states (USFS 2023a; IDFG 2023a; Zaroban et al. 1999). In terms of ecological, cultural, and commercial importance, fishes in family *Salmonidae* and family *Acipenseridae* are among the most important groups of freshwater native fishes found in this hydrologic region (ODFW 2005a,b).

Within the Pacific Northwest hydrologic region, the BLM manages lands in Washington, Oregon, and Idaho that are associated with a diverse array of aquatic habitats, including rivers, streams, ponds and lakes that support both coldwater and warmwater species (BLM 2023i,j). BLM-managed lands in Oregon and Washington support game species such as salmon, sturgeon, steelhead, and trout as well as native non-game species such as the Foskett speckled dace and Alvord chub (BLM 2023i). Although most of Idaho falls within the Columbia River basin, where coldwater species such as salmon, steelhead, sturgeon, and trout are dominant, a substantial portion of the lands managed by BLM in Idaho are also within arid regions in the southern portion of the state

(BLM 2023j). Desert streams in arid areas of Idaho support some important native species, including Columbia River redband trout, speckled dace, and redside shiners (BLM 2023j)

Salmonids (e.g., salmon, trout, grayling, charr, and whitefish) require relatively clear and cold freshwater habitats during part or all of their life cycles, and depend greatly on the aquatic and riparian conditions, and may be dependent on the conditions of surrounding forests and rangelands to ensure their survival. Some species of salmonids within this hydrologic region are anadromous (i.e., they spawn in freshwater but spend part of their life cycle at sea). These species require large stream and river systems with direct ocean access. In the Pacific Northwest, streams that support important stocks of anadromous salmon within BLM-administered lands include those within the Columbia, Snake, Umpqua, and Rogue river basins. Because of the need for anadromous salmon to migrate between ocean and freshwater environments in order to reproduce and to become adults, one of the major factors that has affected the distribution and survival of salmon stocks is the construction of obstacles to migration (e.g., dams, culverts, and road crossings) in streams and rivers used by these species (ODFW 2005a,b). There are many ongoing efforts by several agencies to improve aquatic connectivity that has opened up access to many miles of streams for aquatic species.

Sturgeon occur in the larger river systems within the region. Anadromous populations are present in the Columbia River and its tributaries in Washington and Oregon (CDFW 2023a), the Umpqua and Rogue rivers of Oregon, and portions of the Snake and Salmon rivers in Idaho (Wallace and Zaroban 2013). White sturgeon (*Acipenser transmontanus*), the largest freshwater fish in North America, are usually anadromous, although landlocked populations are present in portions of the Columbia River drainage and in the Snake, Lower Salmon, and Kootenai rivers in Idaho, and in the Kootenai River in Montana (Wallace and Zaroban 2013; IDFG 2012; Montana Natural Heritage Program and Montana Fish, Wildlife and Parks 2023).

In addition to native fishes, various freshwater fish species have been introduced into aquatic systems throughout the Pacific Northwest States (Zaroban et al. 1999). Many of these non-native species have been introduced to promote sportfishing opportunities. Introduced salmonids (such as brook, brown, lake, and rainbow trout), sunfishes, basses, walleye, and northern pike (family *Esocidae)* now support much, if not most, of the non-native sport fishing opportunities within the region (Moyle and Marchetti 2006; Moyle and Davis 2001).

A variety of aquatic invertebrates occur in aquatic habitats of the Pacific Northwest. The diversity of aquatic insects is generally lower in glacier-fed streams; whereas streams flowing through conifer forests typically support a more diverse aquatic invertebrate fauna, including many types of mayflies, stoneflies, and caddisflies. Freshwater mollusks, including mussels (Nedeau et al. 2009) and snails, are also important components of the invertebrate fauna in some aquatic ecosystems.

4.4.2.2 Lower Colorado, Rio Grande, and Great Basin Hydrologic Regions

As described in Section 4.20.1 (Surface Water Resources), the Lower Colorado, Rio Grande, and Great Basin hydrologic regions include arid areas in Arizona, Nevada, New Mexico, southwestern Utah, and south-central Colorado (Figure 4.20-1). The natural hydrology of Southwestern desert rivers and streams in these hydrologic regions is highly variable and episodic, with hydrologic inputs typically occurring in pulses of short duration. Springs and seeps also occur throughout the desert ecosystem within these hydrologic regions, ranging from quiet pools or trickles to small headwater streams. Many of the larger springs discharge warm water, with temperatures that are greater than the mean annual air temperature. Water conditions in springs can range from freshwater to highly mineralized, and some of these springs contain very low dissolved oxygen levels.

Although relatively few fish and invertebrate species may occur within some desert streams, springs, and pools, the native species that do occur are often specially adapted to the conditions in these systems, and over 80% of desert fish are endemic (i.e., native to only a single locality) (Rinne and Minckley 1991; USGS 2005; Mueller and Marsh 2002; Desert Fish Habitat Partnership Workgroup 2008). Natural flow regimes play an important role in sustaining the existing native fish populations and maintaining the ecological integrity of the aquatic ecosystems in these arid regions (e.g., Poff et al. 1997; Propst et al. 2008; Eby et al. 2003; Lytle and Poff 2004). Overall, non-native fish species in these hydrologic regions now outnumber natives in terms of numbers of species, population densities, and, often, biomass at many localities (Mueller and Marsh 2002; Olden and Poff 2005; Rinne and Minckley 1991). Common non-native fishes include sunfishes and black basses, trout, several species of catfishes (family *Ictaluridae),* pike (family *Esocidae),* and temperate basses (family *Percithyidae)* (Mueller and Marsh 2002).

Surface water features in arid ecosystems can contain a seasonally variable community of aquatic invertebrates (Levick et al. 2008; Steward et al. 2022; Vander Vorste et al. 2019). In intermittent streams, invertebrate communities are profoundly structured by habitat variables, such as short and long-term trends in seasonal flooding, drought duration, proximity to perennial water, and instream drought refugia (Stanley et al. 1994; Sponseller et al. 2010; Lake 2003; Steward et al. 2022; Vander Vorste et al. 2019). Invertebrates have several adaptations to dry conditions. Some invertebrates employ physiological mechanisms such as desiccation tolerance (e.g., *Chironomidae* and *Oligochaetes)* and aestivation during dry periods. Other invertebrates survive seasonal drying by using a variety of behavioral mechanisms. For example, invertebrates in intermittent streams can burrow into the hyporheic zone or drift to perennial reaches as the stream dries (Levick et al. 2008; Lytle et al. 2008; Steward et al. 2022; Vander Vorste et al. 2019). Invertebrates that live in fishless ephemeral streams or pools are typically either aquatic opportunists (i.e., species that occupy both temporary and permanent waters) or specialists adapted to living in temporary aquatic environments (Graham 2002). Ostracods (seed shrimp) and small planktonic crustaceans (e.g., copepods or cladocerans), and branchiopod crustaceans such as fairy shrimp could occur, as could aquatic insects like beetles, water boatman *(Heteroptera),* larval flies

(Diptera), and dragonflies *(Odonata)* (Graham 2002; URS Corporation 2006). Even though many ephemeral aquatic habitats are populated with widespread species, some contain species endemic to particular geographic regions or specific habitats.

The native fish community within the lower Colorado River hydrologic region is dominated by fishes within the minnow and sucker families. The Lower Colorado River itself was historically a warm, turbid, and swift river (Schmidt 1993). Construction of dams within the region, such as the Glen Canyon and Hoover dams on the main-stem Colorado River, has altered habitat conditions and changed flow regimes in some of the major river systems by creating a series of cold, clear impoundments. These changes, along with the introduction of non-native fishes and a variety of other anthropogenic influences, have resulted in declines in native fish populations throughout much of the lower Colorado River Basin (Mueller and Marsh 2002; Olden and Poff 2005; Propst et al. 2008). A variety of protected native fish species occur within the basin, including the endangered Gila trout, spikedace, headwater chub, and razorback sucker (Section 4.4.4).

The Rio Grande originates in the Rocky Mountains of southwestern Colorado and meanders about 1,900 mi (3,058 km) across Colorado, New Mexico, and Texas before terminating at the Gulf of Mexico. BLM-administered lands within the Rio Grande region are primarily limited to the upper and middle reaches of this drainage. Most precipitation in the basin falls as snow near its headwaters or as rain near its mouth, while little water is contributed to the system along the middle reaches of this river (Langman and Nolan 2005). Prior to the construction of dams such as the Cochiti Dam, the Rio Grande had characteristics similar to the Colorado River, with warm water and a high sediment load. Dams and the resulting reservoirs have given rise to slower, clearer, and colder water. The Rio Grande contains more than 16 families of fishes in the non-tidal portions of the river, including a diverse minnow assemblage. Benthic invertebrate sampling in portions of the Rio Grande in New Mexico revealed that caddisflies, mayflies, black flies, and chironomids were dominant (Dahm et al. 2005). Pupfish can be found in desert springs. Modification of stream habitat within the Rio Grande Basin due to impoundments, water diversion for agriculture, stream channelization, and the introduction of non-native fishes has affected the abundance and distribution of the Rio Grande silvery minnow, a species that was once widely distributed in the Pecos River and Rio Grande, but is now federally listed as endangered. Currently, 157 mi (253 km) of the Rio Grande has been designated as critical habitat for this species (Section 4.10.4; USFWS 2010).

The Great Basin hydrologic region covers an arid expanse of approximately 190,000 mi^2 (492,000 km^2) and is the area of internal drainage between the Wasatch Mountains of Utah and the Sierra Nevada Range in California and Nevada (Figure 4.7-1). Streams in this area never reach the ocean, but instead drain toward the interior of the basin, resulting in terminal lakes such as Mono Lake and the Great Salt Lake, marshes, or similar hydrologic sinks that are warm and saline (Sigler and Sigler 1987). Some fish species that inhabit the Great Basin hydrologic region are adapted to extreme conditions (Sigler and Sigler 1987). Trout are found in lakes and streams at higher elevations within the basin. Bonneville cutthroat trout have persisted in the isolated, cool mountain streams of the eastern portion of the Great Basin hydrologic region, while Lahontan cutthroat trout populations occupy small, isolated habitats throughout the basin, including some areas on BLM-managed lands (e.g., the Lahontan Cutthroat Trout Natural Area in the Black Rock Range in Nevada; BLM 2023k). These trout species are tolerant of high temperatures (greater than 80°F [27°C]), large daily fluctuations in temperature (up to 35°F [19°C]), and the higher alkalinity present in some of the aquatic habitats within this hydrologic region (USFWS 2023c). Water diversions, subsistence harvest, and stocking of non-native fish have caused the extirpation of the Bonneville cutthroat trout from most of its range within the Great Basin hydrologic region. Lahontan cutthroat trout, which were once common in desert lakes and in large rivers, such as the Humboldt, Truckee, and Walker rivers, have declined in numbers overall and have disappeared in many areas (USFWS 2023c).

Various native and non-native minnows are common throughout streams and lakes of the Great Basin hydrologic region (Sigler and Sigler 1987). Native pupfish species, which are tolerant of high temperature ranges compared with many other fish species, occur in some thermal artesian springs and in some streams in portions of Nevada and California (Sigler and Sigler 1987). Because the isolation of these pupfish populations makes them more prone to extinction, most of them, such as the endangered Owens pupfish, which are present on some lands managed by the BLM in California (USFWS 2022b), are currently listed as endangered or threatened under the ESA or are considered species of special concern by the states where they occur. Several species of springsnails (*Pyrgulopsis* spp. and *Tryonia* spp.) are also protected or proposed for protection under the ESA.

4.4.2.3 California Hydrologic Region

Primarily composed of areas within the state of California, the California hydrologic region (Figure 4.20-1) can be broadly divided into northern and southern freshwater fish habitat regions (although finer-scale zoogeographic regions can also be delineated [Moyle and Marchetti 2006]). The northern region extends from the Oregon border south to Sacramento (the southernmost extent of anadromous salmon distribution in North America). This region includes rain-fed coastal streams, snow-fed streams of the western Sierra Nevada, and the Central and San Joaquin valleys. Habitat characteristics and the associated fish assemblages are relatively similar to those in the western portion of the Pacific Northwest hydrologic region (Section 4.4.2.1).

Freshwater fish habitats within the southern portion of the California hydrologic region are located chiefly within the arid southeastern portion of the state. Many of the aquatic habitats on BLM-administered lands in arid zones are managed according to the DRECP (BLM 2016j). As described above for the Lower Colorado and Great Basin regions (Section 4.4.2.2), native fish communities containing taxa such as pupfish and minnows occur in the lower elevations, and cutthroat trout populations occur in the mountainous regions.

Approximately 125 species of freshwater, anadromous, and euryhaline (saline-tolerant) fish occur in the inland waters of California (Moyle and Davis 2001). About 67 of these are native resident or anadromous species, 53 are non-native species, and five are marine species that occur in freshwater habitats (Moyle and Davis 2001). Most of the native fish species are endemic to California, a situation typical of fish faunas in regions with arid climates (Moyle and Marchetti 2006). New non-native fish species have become established in the state at the rate of about one species every three years since 1981 (Moyle and Davis 2001).

4.4.2.4 Upper Colorado River Hydrologic Region

The Colorado River Basin falls within two hydrologic regions: the Upper and Lower Colorado River hydrologic regions, with a dividing line near Lee's Ferry, Arizona. Aquatic resources in the Lower Colorado River hydrologic region are described in Section 4.4.2.2. The Upper Colorado River hydrologic basin is predominantly within a subarid to arid region that includes portions of Wyoming, Colorado, Utah, Arizona, and New Mexico (Figure 4.20-1). Falling primarily between the Wasatch Mountains in Utah and the Rocky Mountains in Colorado, this hydrologic region is composed of three major subbasins: the Green River subbasin, the upper Colorado River subbasin, and the San Juan-Colorado River subbasin.

Coldwater fish assemblages in the Upper Colorado River hydrologic region typically include salmonids, such as mountain whitefish and trout. Conditions that support such species are usually found in ponds, lakes, or reservoirs at higher elevations and in the headwaters of selected rivers and streams where water temperatures are cooler. Because deepwater releases from dams at some large, deep reservoirs can introduce cold, clear waters into rivers, coldwater fish assemblages have also become established in historically warmwater sections of some rivers, such as the portions of the Green River immediately downstream (i.e., tailwaters) of Fontenelle and Flaming Gorge dams. Warmwater assemblages typically occur at lower elevations, where waters tend to be warmer and more turbid. Warmwater fish communities within the Upper Colorado River Basin include species of minnows, chubs, suckers, sunfishes, black basses, and catfishes.

Historically, only 12 species of fish were native to the Upper Colorado River Basin, including five minnow species, four sucker species, two salmonids, and the mottled sculpin (family *Cottidae).* Four of these native species (humpback chub, bonytail, Colorado pikeminnow, and razorback sucker) are now federally listed as threatened or endangered, and critical habitat for these species has been designated within the Upper Colorado River Basin (Section 4.4.4). In addition to native fish species, more than 25 non-native fish species are now present in the basin, often as a result of intentional introductions (e.g., for establishment of sport fisheries) (Muth et al. 2000; McAda 2003; LaGory et al. 2019). While most of the trout species found within the Upper Colorado River Basin are introduced non-natives (e.g., rainbow, brown, and some strains of cutthroat trout), mountain whitefish and Colorado River cutthroat trout are native to the basin. Although it was once common within the upper Green River and upper Colorado River watersheds, the Colorado River cutthroat trout is now found only in isolated subdrainages in Colorado, Utah, and Wyoming and is a species of concern in those states (Hirsch et al. 2006).

4.4.2.5 Missouri River Basin Hydrologic Region

Portions of Colorado east of the Continental Divide, and most of Wyoming and Montana fall within the Missouri River hydrologic region (Figure 4.20-1). The mainstem Missouri River and the Yellowstone River, which joins the Missouri River in western North Dakota, are the predominant watersheds in Montana (Reclamation 2021). Major watersheds in northern Wyoming, including the Bighorn, Tongue, and Powder River systems, drain to the Missouri River via the Yellowstone River; southern Wyoming and northern Colorado fall within the North Platte and South Platte watersheds, respectively (Reclamation 2021; WGFD 2017). These watersheds drain to the Missouri River via the mainstem Platte River, which runs through Nebraska. The Missouri River historically carried a heavy silt load from tributaries and has a wide and diverging channel that creates shifting sandy islands, spits, and pools. Streams flowing through the arid, desert plains of Wyoming and Colorado are characterized by low gradients, meandering or braided channels, and sand and gravel substrates. In addition to low gradient turbid streams, a large number of colder, less turbid tributaries flow through the Montana, Wyoming and Colorado portions of the Missouri River basin.

At least 14 major dams have been built in the Montana, Wyoming, and Colorado portions of the Missouri River basin for hydropower, flood control, and irrigation (Reclamation 2021). This has resulted in development of a number of long and relatively deep reservoirs (lakes) within the basin and has altered water flow and temperature regimes and decreased sediment loads in portions of rivers downstream of the dams (Reclamation 2021).

Many of the native fish species in the Missouri River basin are adapted to turbid and dynamic conditions and the fish communities largely consist of benthic fishes such as sturgeon, catfish, and minnows, and chubs (Montana Fish, Wildlife, and Parks 2023; WGFD 2017; BLM 2023l). Tributaries with colder, clearer water and sections of rivers immediately downstream of some dams support a variety of salmonid species, including rainbow trout, brown trout, brook trout and native cutthroat trout (Montana Fish, Wildlife, and Parks 2023; WGFD 2017; BLM 2023l). Examples of introduced species in the Missouri River drainage include largemouth and smallmouth bass, walleye, and white crappie (Montana Fish, Wildlife, and Parks 2023; WGFD 2017; BLM 2023l).

4.4.3 Wildlife

The various ecoregions encompassed by the 11-state planning area (Section 4.4.1) include a wide range of habitats that support a high diversity of terrestrial and aquatic wildlife species. Table 4.4-2 lists the number of wildlife species are known to occur within the 11-state planning area. Many of these species may be expected to occur within or near a solar energy facility or associated ancillary facilities (e.g., transmission lines and access roads), depending on the plant communities and habitats present within the project area.

The BLM and other federal agencies that administer public lands have active wildlife habitat management programs. These programs are aimed largely at habitat protection and improvement to ensure sustainable populations are maintained on public lands. The general objectives of wildlife management are to (1) in coordination with Tribal, state, and federal partner program objectives, maintain or increase native and other desired fish and wildlife species' habitat abundance and distribution, particularly for those that are hunted or fished; (2) maintain and/or improve habitat quality and connectivity; and (3) ensure that the landscapes to which fish and wildlife species, populations, and communities are adapted are managed, protected, and restored in an ecologically sound manner. ACECs may be designated to protect fish and wildlife resources including but not limited to habitat for endangered, sensitive, or threatened species, or habitat essential for maintaining species diversity. Management of ACECs is discussed in Section 4.16.2.1.

The BLM MS 6500 policy emphasizes and integrates the BLM's responsibility to fish and wildlife development and utilization as a principal or major multiple use of public lands as defined by FLPMA. This policy also addresses the DOI's responsibility to proactively manage federally listed species in accordance with the ESA and consistent with BLM MS- 6840; migratory birds; and some anadromous fish under the Magnuson Stevens Act; and to conserve fish and wildlife as directed in 43 CFR Part 24 in collaboration with lead state agencies. The U.S. Fish and Wildlife Service (USFWS) is responsible for oversight of migratory bird species and most federal threatened, endangered, proposed, or candidate species. Management of threatened, endangered, and other BLM special status species is discussed in Section 4.4.4. The National Oceanic and Atmospheric Administration (NOAA) oversees the protection of seabirds through the NOAA Fisheries' National Seabird Program (Ballance et al. 2019).

Table 4.4-2. Minimum Number of Wildlife Species in the 11-State Planning Area[a]

State	Amphibians	Reptiles	Birds	Mammals	Insects[b]
Arizona	13	61	146	78	845
California	75	100	650	220	809
Colorado	18	49	473	130	802
Idaho	16	27	307	123	720
Montana	15	20	456	115	728
Nevada	15	56	487	131	772
New Mexico	27	114	416	115	863
Oregon	31	30	400	136	716
Utah	16	47	322	148	762
Washington	27	28	486	171	713
Wyoming	13	52	465	142	761

[a] Excludes marine mammal species, native species that have been extirpated and not subsequently reintroduced into the wild, and feral domestic species.

[b] Species counts for insects may not be as accurate as other taxa as they are not as widely understood.

Sources: AZGFD (2022); BLM (2023m); CDFW (2015); IDFG (2023b); NDOW (2013); WYNDD (2023); MNHP (2023a); OSU (2023); ODFW (2023); WADNR (2019); UDWR (2023a); InsectIdentification.org (2023).

The following discussions present general descriptions of the wildlife species that may occur on BLM-administered lands where solar energy development could occur. See Appendix F, Section F.4.3, for more information about wildlife species that may occur on BLM-administered lands where solar energy development could occur.

4.4.3.1 Amphibians and Reptiles

The 11-state planning area supports a variety of amphibians and reptiles, many of which may occur at or in the vicinity of an individual solar energy facility. The number of amphibian species reported from these states ranges from 13 species in Wyoming and Arizona to 75 species in California. The number of reptile species reported from these states ranges from 20 species in Montana to 114 species in New Mexico (Table 4.4-2). The amphibians include frogs, toads, and salamanders occupying a variety of habitats that include forested headwater streams in mountain regions, marshes, and wetlands, and xeric habitats in the desert areas of the Southwest. Many xeric amphibian species may be particularly vulnerable to solar energy development because they are endemic with small home ranges (Griffis-Kyle 2016). These desert amphibians often excavate deep burrows where they spend the majority of the year and they reproduce in temporary pools produced by sporadic rainfall (Székely et al. 2018). The reptile species include a variety of turtles, snakes, and lizards. Many reptiles may also be susceptible to disturbance due to their burrowing habits and small home ranges (Trimble and van Aarde 2014; Doherty et al. 2020; Lovich and Ennen 2011). A number of Priority Amphibian and Reptile Conservation Areas (PARCAs) have been identified in seven of the planning area states (Washington, Oregon, California, Nevada, Arizona, New Mexico, and Colorado). The identification of additional PARCAs are underway in Utah, Idaho, Montana, and Wyoming. Though BLM has no requirement to manage PARCAs, these areas identify valuable habitat for priority reptiles and amphibians throughout the United States, using a system informed by scientific criteria and expert review. Information on PARCAs and an interactive map of locations can be found on the Amphibian and Reptile Conservancy, Inc., website (ARC 2023).

4.4.3.2 Birds

Several hundred species of birds are known to occur within the 11-state planning area (Table 4.4-2), ranging from 146 in Arizona to 650 in California. While not all bird species can be discussed in this section, individual bird species occurring in a proposed solar project ROW would be identified during project specific NEPA review. The bird species in coastal areas of the 11-state planning area include oceanic species such as boobies, gannets, frigatebirds, fulmars, and albatrosses that would not be expected in areas where solar energy development may occur.

A number of Important Bird Areas (IBAs) have been identified by the National Audubon Society within the 11-state planning area. IBAs are locations that provide essential habitats for breeding, wintering, or migrating birds. While these sites can vary in size, they are discrete areas that stand out from the surrounding landscapes. IBAs must support one or more of the following:

- Species of conservation concern (e.g., threatened or endangered species);
- Species with restricted ranges;
- Species that are vulnerable because their populations are concentrated into one general habitat type or ecosystem; or
- Species or groups of similar species (e.g., waterfowl or shorebirds) that are vulnerable because they congregate in high densities.

Though BLM has no requirement to manage IBA areas, the IBA program has become a key component of many bird conservation efforts (Audubon Washington 2015). Information on the IBA program and a list of IBAs for each state can be found on the National Audubon Society website (National Audubon Society undated).

4.4.3.2.1 Migratory Routes

Many of the bird species found in the 11-state planning area are seasonal residents within individual states and exhibit seasonal migrations. These birds include waterfowl, shorebirds, raptors, and neotropical songbirds. The 11-state planning area falls within two of the four major North American migration flyways (PFC 2023; CFC 2023a)—the Central Flyway and the Pacific Flyway (see Appendix F, Section F.4.3.2, for a map of the flyway administrative boundaries). These pathways are used in spring by birds migrating north from wintering areas to breeding areas and in fall by birds migrating south to wintering areas. These migration flyways are generalized pathways and do not include rigid boundaries. Specific migration paths vary by species and taxonomic group and migration can occur anywhere within the 11-state planning area.

The Central Flyway includes the Great Plains–Rocky Mountain routes (Lincoln et al. 1998). These routes extend from the northwest Arctic coast south between the Mississippi River and the Rocky Mountains. Within the 11-state planning area, this flyway encompasses all or most of Colorado, Montana, New Mexico, and Wyoming and includes habitats important to migratory birds, such as Playa Lakes, the alpine tundra, prairie potholes, and the northern Great Plains (CFC 2023a,b). More than 50% of North America’s migratory waterfowl use this flyway along with many shorebirds and hundreds of thousands of sandhill cranes (Fritts 2022). This flyway is relatively simple, with the majority of birds making relatively direct north and south migrations.

The Pacific Flyway includes the Pacific Coast Route, which occurs between the Rocky Mountains and the Pacific coast of the United States (ABC 2023). In the 11-state planning area, this flyway encompasses the states of Arizona, California, Idaho, Oregon, Nevada, Utah, and Washington, and the portions of Colorado, Montana, New Mexico, and Wyoming that are west of the Continental Divide (PFC 2023). Some birds using this flyway travel as far south as Patagonia and as far north as Alaska. For example, the rufous hummingbird flies 3,000 miles between Mexico and British Columbia using this flyway (ABC 2023). Songbirds and shorebirds also frequent this flyway with large numbers of shorebirds making stopovers at the Great Salt Lake (ABC 2023). Some other hotspots used by migrating birds within this flyway include Malheur National

Wildlife Refuge, Gray Lodge Wildlife Area, Monterey Bay, and Don Edwards San Francisco Bay National Wildlife Refuge (ABC 2023).

The regulatory framework organized to protect migratory birds includes the MBTA and E.O. 13186: "Responsibilities of Federal Agencies to Protect Migratory Birds" (66 FR 3853). This law and executive order are discussed in Sections 3.3.1.1 and 3.3.1.2, respectively.

4.4.3.2.2 Waterfowl, Wading Birds, and Shorebirds

Waterfowl (ducks, geese, and swans), wading birds (herons and cranes), and shorebirds (plovers, sandpipers, and similar birds) are among the more abundant groups of birds in the 11-state planning area. Many of these species exhibit extensive migrations from breeding areas in Alaska and Canada to wintering grounds in Mexico and southward (Lincoln et al. 1998). While many of these species nest in Canada and Alaska, a number of them, such as the American avocet (*Recurvirostra americana*), willet (*Catoptrophorus semipalmatus*), spotted sandpiper (*Actitis macularia*), gadwall (*Anas strepera*), and blue-winged teal (*A. discors*), also nest in suitable habitats in many of the western states (National Geographic Society 1999). For example, millions of shorebirds and waterfowl use the saline lake complex in the western United States for nesting (Wurtsbaugh et al. 2017). Most are ground-level nesters and many sometimes forage in relatively large flocks on the ground or water. Within the region, migration routes for these birds are often associated with riparian corridors and wetland or lake stopover areas.

Major waterfowl species hunted in the 11-state planning area include the mallard (*Anas platyrhynchos*) and Canada goose (*Branta canadensis*). Other species commonly hunted in the Pacific and Central flyways include gadwall (*Mareca strepera*), American coot (*F. americana*), American wigeon (*A. americana*), teal (*A.* spp.), northern pintail (*A. acuta*), northern shoveler (*A. clypeata*), and snow goose (*Chen caerulescens*) (Raftovich et al. 2022). Hunting for sandhill cranes (*Grus canadensis*) also occurs in Arizona, Colorado, Idaho, Montana, New Mexico, Utah, and Wyoming in at least a portion of the state (CFWMGBTC 2018; IDFG 2023c; Sharp et al. 2005). Various conservation and management plans exist for waterfowl, shorebirds, and waterbirds.

4.4.3.2.3 Passerines

Songbirds of the order Passeriformes (often referred to as "passerines") represent the most diverse category of birds, with warblers and sparrows representing the two most diverse groups. The passerines exhibit a wide range of seasonal movements, with some species remaining as year-round residents in some areas (e.g., pinyon jay [*Gymnorhinus cyanocephalus*]) and migratory in others; and still other species undergoing migrations of hundreds of miles or more (Lincoln et al. 1998). Nesting occurs in vegetation from near ground level to the upper canopy of trees. Some species, such as thrushes and chickadees, are relatively solitary throughout the year, while others, such as swallows and blackbirds, may be found in small to large flocks at various times of year. Foraging may occur in flight (e.g., swallows and swifts), on vegetation, or on the ground (e.g., warblers, finches, and thrushes). Various conservation and management plans exist for neotropical migrants and other landbirds, including the Partners in Flight

Landbird Conservation Plan (Rosenberg et al. 2016) and numerous physiographic area and state plans. These plans can be accessed from the Partners in Flight website (Partners in Flight 2023).

Many neotropical migrants are protected by the ESA (discussed further in Section 4.4.4). In addition to the federal regulatory framework, individual states have regulations that apply to the general protection of avian species. While the BLM is not bound by state regulations, they are an important consideration in that they apply to private projects or actions that take place on BLM-administered lands.

4.4.3.2.4 Birds of Prey

Birds of prey include raptors (hawks, falcons, eagles, kites, and osprey), owls, and vultures. These species represent the top avian predators in many ecosystems. Common raptor and owl species include the red-tailed hawk (*Buteo jamaicensis*), ferruginous hawk (*Buteo regalis*), prairie falcon (*Falco mexicanus*), peregrine falcon (*Falco peregrinus*), sharp-shinned hawk (*Accipiter striatus*), northern harrier (*Circus cyaneus*), Swainson's hawk (*B. swainsoni*), American kestrel (*Falco sparverius*), golden eagle (*Aquila chrysaetos*), great horned owl (*Bubo virginianus*), short-eared owl (*Asio flammeus*), and burrowing owl (*Athene cunicularia*). The raptors and owls vary considerably among species with regard to their seasonal migrations, with some species being nonmigratory (year-round residents); others being migratory in the northern portions of their ranges and nonmigratory in the southern portions of their ranges; and still other species being migratory throughout their ranges.

Raptors forage on a variety of prey, including small mammals, reptiles, other birds, fish, invertebrates and, at times, carrion. They typically perch on trees, utility support structures, highway signs, and other high structures that provide a broad view of the surrounding topography, and they may soar for extended periods at relatively high altitudes. Depending on the species, raptors forage either from a perch or on the wing, and all forage during the day. Owls also perch on elevated structures and forage on a variety of prey, including mammals, birds, and insects. Forest-dwelling species typically forage by diving on prey from a perch, while open-country species hunt on the wing while flying low over the ground. While generally nocturnal, some owl species are also active during the day.

Vultures are represented by three species: the turkey vulture (*Cathartes aura*), which occurs in each of the 11 western states; the black vulture (*Coragyps atratus*), which is reported from Arizona, California, and New Mexico; and the endangered California condor (*Gymnogyps californianus*), reported from Arizona, California, Nevada, Utah, and Wyoming. These birds are large, soaring scavengers that feed on carrion.

Raptors, or birds of prey, and the majority of other birds in the United States are protected by the MBTA. The bald eagle (*Haliaeetus leucocephalus*) and golden eagle are also protected under the BGEPA, which prohibits the taking or possession of, or commerce in, bald and golden eagles, unless authorized by the USFWS. The Secretary of the Interior can authorize the taking of eagle nests that interfere with resource development or recovery operations (81 FR 91494). Several species of birds of prey are also managed under the ESA and are discussed further in Section 4.4.4. The BLM field offices have specific management guidelines for raptors, including eagles. States also have regulations regarding the protection of raptors that would be applicable to private projects or actions conducted on BLM-administered lands.

4.4.3.2.5 Upland Game Birds

Upland game birds that occur in at least a portion of the 11-state planning area include dusky grouse (*Dendragapus obscurus*), ruffed grouse (*Bonasa umbellus*), spruce grouse (*Canachites canadensis*), greater sage-grouse (*Centrocercus urophasianus*), Gunnison sage-grouse (*C. minimus*), sharp-tailed grouse (*Tympanuchus phasianellus*), lesser prairie chicken (*Tympanuchus pallidicinctus*), Gambel's quail (*Callipepla gambelii*), California quail (*C. californica*), scaled quail (*C. squamata*), mountain quail (*Oreortyx pictus*), mourning dove (*Zenaida macroura*), and white-winged dove (*Z. asiatica*). Introduced species include ring-necked pheasant (*Phasianus colchicus*), northern bobwhite (*Colinus virginianus*), chukar (*Alectoris chukar*), and gray partridge (*Perdix perdix*). The wild turkey (*Meleagris gallopavo*) is native to Arizona, Colorado, and New Mexico and has been introduced in the other states. All the upland game bird species are year-round residents.

Most concerns about upland game birds in the 11-state planning area have focused on the potential impacts on the greater sage-grouse, the Gunnison sage-grouse, and the Bi-State Distinct Population Segment of the greater sage-grouse which will be discussed in Section 4.4.4.

4.4.3.3 Mammals

The number of mammal species known to occur within the 11-state planning area ranges from 78 species in Arizona to 220 species in California (Table 4.4-2). The following discussion emphasizes big game and small mammal species that (1) have key habitats within or near the areas in which solar energy development may occur; (2) are important to humans (e.g., big and small game and furbearer species); and/or (3) are representative of other species that share important habitats.

4.4.3.3.1 Big Game Species

The primary big game species within the 11-state planning area include elk (*Cervus canadensis*), mule deer (*Odocoileus hemionus*), white-tailed deer (*O. virginianus*), pronghorn (*Antilocapra americana*), bighorn sheep (*Ovis canadensis*), American black bear (*Ursus americanus*), mountain goat (*Oreamnos americanus*), moose (*Alces americanus*), and cougar (*Puma concolor*). Several other big game species occur within a few states. These include the American bison (*Bos bison*) in Arizona, Montana, and Utah; gray wolf (*Canis lupus*) in Idaho and Montana; African oryx (*Oryx gazella*), ibex (*Capra ibex*), and Barbary sheep (*Ammotragus lervia*) in New Mexico; javelina (*Pecari tajacu*) in Arizona and New Mexico; and the non-native feral pig (*Sus scrofa*) in California. The African oryx, ibex, and Barbary sheep are non-native species that were introduced for hunting.

A number of the big game species make migrations when seasonal changes reduce food availability, when movement within an area becomes difficult (e.g., due to snow pack), or when local conditions are not suitable for calving or fawning. Established migration corridors for these species provide an important transition habitat between seasonal ranges and allow populations to exploit temporally variable food resources (Kauffman et al. 2022). Maintaining genetic interchange through landscape linkages among subpopulations is also essential for long-term survival of species. Maintaining migration corridors and landscape linkages, especially when seasonal ranges or subpopulations are far removed from each other, can be difficult because of the various land ownership mixes that often need to be traversed (Sawyer et al. 2005, 2022).

See Appendix F, Section F.4.3.2, for general overviews of the primary big game species; maps of big game migration corridors and winter ranges, as mapped by state and federal natural resource agencies; and the acreage of these areas intersecting BLM-administered lands in each state.

4.4.3.3.2 Small Mammals

Small mammals include small game, furbearers, and nongame species. Many small mammals species may be susceptible to solar energy development due to their burrowing habits and small home ranges (Benítez-López et al. 2010; Lovich and Ennen 2011). Small game species that occur within the 11-state planning area include black-tailed jackrabbit (*Lepus californicus*), white-tailed jackrabbit (*L. townsendii*), desert cottontail (*Sylvilagus audubonii*), eastern cottontail (*Sylvilagus floridanus*), mountain cottontail (*S. nuttallii*), pygmy rabbit (*Brachylagus idahoensis),* squirrels (*Sciurus* spp.), snowshoe hare (*L. americanus*), and yellowbellied marmot (*Marmota flaviventris*). Furbearer species in the 11-state planning area include American badger (*Taxidea taxus*), American mink (*Neogale vison*), American marten (*Martes americana*), North American porcupine (*Erethizon dorsatum*), American beaver (*Castor canadensis*), northern river otter (*Lontra canadensis*), bobcat (*Lynx rufus*), common muskrat (*Ondatra zibethicus*), coyote (*Canis latrans*), fisher (*Pekania pennanti*), red fox (*Vulpes vulpes*), gray fox (*Urocyon cinereoargenteus*), swift fox (*Vulpes velox*), nutria (*Myocastor coypus*), western spotted skunk (*Spilogale gracilis*), Virginia opossum (*Didelphis virginiana*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), short-tailed weasel (*Mustela richardsonii*), and long-tailed weasel (*Mustela frenata*). Nongame species include but are not limited to bats, shrews, mice, voles, chipmunks, and many other rodent species. Twenty-nine species of bats are known to occur within the 11-state planning area (BCI 2023). Bats may be of particular importance because of their function in vector control and the fact that bat populations have declined in many parts of North America due to white-nose syndrome, wind turbines, habitat loss, and climate change (WDFW 2023). White-nose syndrome has been confirmed in 12 species of bats, and seven of those species occur within the 11-state planning area (big brown bat, cave bat, fringed myotis, little brown bat, long-legged bat, western long-eared bat, and Yuma bat; WNSRT 2023).

4.4.3.3.3 Insects

The 11-state planning area supports a variety of insects, many of which may be found at or in the vicinity of an individual solar energy facility. Species counts for insects may not be as accurate as other taxa as they are not as widely understood. The number of insect species known to occur within these states ranges from 713 species in Washington to 863 species in New Mexico. The insects include beetles (Coleoptera), ants, bees, and wasps (Hymenoptera), butterflies and moths (Lepidoptera), grasshoppers and crickets (Orthoptera), dragonflies (Odonata), and true bugs (Hemiptera) that occupy a variety of habitats. Declines in insect diversity and abundance have been recorded across the globe due to habitat loss, pesticide use, invasive species, and light pollution (Forister et al. 2019). Some recent research has been conducted to try to reduce the impact of solar energy facilities on insect populations, and pollinators in particular, by planting native seed mixes in or around solar energy facilities (Walston et al. 2018). These activities could increase the occurrences of some insect species of concern on the solar sites, such as the monarch butterfly (*Danaus plexippus*). A Candidate Conservation Agreement with Assurances was recently approved by the USFWS to enroll solar energy facilities that provide habitat for the monarch butterfly, with assurances that no additional conservation measures will be imposed if the species becomes listed under the ESA (https://www.fws.gov/initiative/pollinators/monarchs/CCAA-FAQ).

4.4.4 Special Status Species (SSS)

The BLM has established a policy, as specified in BLM Manual MS-6840, *Special Status Species Management* (BLM 2008b), whose purpose is "to provide policy and guidance for the conservation of BLM SSS and the ecosystems upon which they depend on BLM-administered lands." Objectives of the BLM SSS policy are to (1) conserve and/or recover ESA-listed species and the ecosystems on which they depend so that ESA protections are no longer needed for these species, and (2) initiate proactive conservation measures that reduce or eliminate threats to BLM-designated sensitive species to minimize the likelihood of and need for listing of these species under the ESA.

This section identifies the SSS that could occur in the 11-state planning area. Consistent with BLM policy, this section defines SSS to include:

- Species listed as threatened or endangered under the ESA. *Endangered* refers to any species that is in danger of extinction throughout all or a significant portion of its range. *Threatened* is defined as any species that is likely to become endangered within the foreseeable future throughout all or a significant part of its range.
- Species that are proposed for listing or candidates for listing under the ESA. *Proposed for listing* refers to species that have been formally proposed for listing by the U.S. Fish and Wildlife Service (USFWS) or National Marine Fisheries Service (NMFS) by notice in the *Federal Register*. *Candidate* species refers to species for which the USFWS or NMFS has sufficient information on their

biological status and threats to propose them as threatened or endangered under the ESA but for which development of a proposed listing regulation is precluded by other higher priority listing actions.

- Delisted species throughout the post-delisting monitoring period (minimum 5 years; ESA, Section 4(g)), and
- BLM sensitive species as designated on a national level by BLM Headquarters in coordination with the BLM State Directors. Species are designated by the BLM as sensitive when a particular native wildlife, fish, or plant species occurring on BLM-administered lands becomes at risk. BLM periodically reviews and updates its sensitive species list in coordination with state agencies and other partners. Once designated, the BLM works cooperatively with federal and state agencies, Tribes, nongovernmental organizations, and other partners to proactively conserve these species and ensure that activities on public lands do not contribute to the need for their listing under the ESA.

Greater sage-grouse and Gunnison sage-grouse are also SSS. They are discussed in Sections 4.4.4.3 and 4.4.4.4, respectively.

The sources of species status and distribution data are presented in Table 4.4-3. This information includes data provided by state natural resource agencies, BLM field offices, and the USFWS.

Table 4.4-3. Data Sources for Special Status Species Assessment

State	Data Element	Source
All states	ESA-listed endangered, threatened, proposed for listing, candidate	ECOS: Species Reports (USFWS 2023b)
All States—Critical Habitat	USFWS critical habitat	USFWS Threatened & Endangered Species Active Critical Habitat Report (USFWS 2023a)
Arizona	BLM SSS	Updated BLM Sensitive Species List for Arizona (BLM 2017e)
California	BLM special status animals	California Threatened & Endangered Species (BLM undated a)
California	BLM special status plants	BLM Special Status Plants (BLM undated b)
Colorado	BLM special status plants	*BLM—Colorado Special Status Plant Species* (Krening and Palmer 2020)
Colorado	BLM special status animals	*State Wildlife Action Plan: A Strategy for Conserving Wildlife in Colorado* (Colorado Parks and Wildlife 2015)
Idaho	BLM SSS	Idaho Threatened and Endangered Species (BLM undated c)
Idaho	BLM special status plants	Idaho Rare Plants (BLM undated d)
Montana	BLM SSS	Montana Natural Heritage—SOC Report (MNHP 2023b)
Nevada	BLM SSS	BLM Nevada Sensitive and Status Species List (BLM 2017f)
New Mexico	BLM SSS	New Mexico Threatened and Endangered Species (BLM undated e)
Oregon	BLM SSS	Agency Policies and Lists (USFS 2022)
Utah	BLM SSS	Utah Threatened and Endangered Species (BLM undated f)
Washington	BLM SSS	Agency Policies and Lists (USFS 2022)
Wyoming	BLM SSS	Update of the BLM Wyoming Sensitive Species List—2010 (BLM 2010a)
Wyoming	BLM SSS	Wyoming Natural Diversity Database (WYNDD 2023)

Special status species are summarized by state and designating agency in Table 4.4-4.

Table 4.4-4. Special Status Species by State and Designating Agency

State	Federal Status				BLM Sensitive
	Endangered	Threatened	Proposed	Candidate	
Arizona	42	24	2	1	104
California	207	79	13	1	750
Colorado	15	20	3	2	126
Idaho	5	11	1	1	343
Montana	5	11	1	1	93
Nevada	28	19	4	1	605
New Mexico	34	22	4	2	111
Oregon	21	26	2	2	666
Utah	19	23	2	1	152
Washington	11	22	2	1	369
Wyoming	8	11	2	1	82

4.4.4.1 Species Listed, Proposed for Listing, Candidates for Listing Under the ESA

Within the 11-state planning area, 271 plant species and 231 animal species are federally listed as threatened or endangered, proposed for listing, or candidates for listing under the ESA. The animals are 14 species of mollusks, 47 species of arthropods, 64 species of fishes, 17 species of amphibians, 14 species of reptiles, 28 species of birds, and 47 species of mammals. Within the 11-state planning area, California has the largest number of federally listed plant and animal species (300) whereas Idaho and Montana have the fewest (18) (Table 4.4-5). In addition, there are 16 species that have been delisted within the last 5 years. Many, but not all, listed species have recovery plans that includes conservation measures, biological information, and recovery criteria for the species.

The USFWS designates critical habitat for listed species where prudent and determinable. Federal agencies are required to avoid "destruction" or "adverse modification" of designated critical habitat. Designated critical habitats are described in 50 CFR Parts 17 and 226. Designated critical habitat for listed species consists of

- The specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of Section 4 of the ESA, on which are found those physical or biological features (constituent elements) (1) essential to the conservation of the species and (2) that may require special management considerations or protection; and
- Specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of Section 4 of the ESA, upon a determination by the Secretary of the Interior that such areas are essential for the conservation of the species.

Critical habitat is not designated for a listed species when not "prudent or determinable" (§ 424.12 Criteria for designating critical habitat). About half of all federal listed species do not have designated critical habitat. Critical habitat designations may be determined not prudent for reasons including:

- The species is threatened by taking or other human activity and identification of critical habitat can be expected to increase the degree of such threat to the species;
- The present or threatened destruction, modification, or curtailment of a 'species' habitat or range is not a threat to the species, or threats to the 'species' habitat stem solely from causes that cannot be addressed through management actions resulting from consultations under section 7(a)(2) of the ESA;
- Areas within the jurisdiction of the United States provide no more than negligible conservation value, if any, for a species occurring primarily outside the jurisdiction of the United States;

Table 4.4-5. ESA-listed Threatened, Endangered, Candidate or Proposed for Listing Under the ESA

Taxonomic Group	Arizona	California	Colorado	Idaho	Montana	Nevada	New Mexico	Oregon	Utah	Washington	Wyoming
Plant	26	177	17	5	3	13	17	19	25	11	5
Mollusk	2	1	-	4	-	1	7	1	-	-	-
Arthropod	1	34	4	1	3	4	5	7	2	3	2
Fish	19	20	6	2	3	24	16	7	10	2	5
Amphibian	2	17	-	-	-	2	2	1	-	1	1
Reptile	5	9	-	-	-	1	3	4	1	1	-
Bird	7	19	7	1	4	5	4	7	4	7	3
Mammal	7	23	6	5	5	2	8	5	3	11	6
Total	**69**	**300**	**40**	**18**	**18**	**52**	**62**	**51**	**45**	**36**	**22**

- No areas meet the definition of critical habitat; or
- The Secretary otherwise determines that designation of critical habitat would not be prudent based on the best scientific data available.

Designation of critical habitat may be found not determinable when one or both of the following situations exist:

- Data sufficient to perform required analyses are lacking; or
- The biological needs of the species are not sufficiently well known to identify any area that meets the definition of "critical habitat."

Critical habitat in the 11-state planning area (excluding DRECP land) is shown in Figure 4.4-1 and acreages of critical habitat on BLM-administered lands are shown by state in Table 4.4-6. All designated critical habitat that has been mapped by USFWS is excluded under all alternatives. In total, there are 5,405,595 acres of critical habitat designated for animals on BLM-administered lands and 152,259 acres of plant critical habitat. For animals, Oregon and Utah have the greatest acreage of critical habitat on BLM-administered land (over 1 million acres each) while Washington and New Mexico have less than 16,000 acres each. For plants, Idaho has the greatest acreage of critical habitat and Nevada, New Mexico, and Wyoming have the least. Within the 11-state planning area, critical habitat has been designated for 99 species. California has critical habitat for the greatest number of species.

Table 4.4-6. Number of Species with Critical Habitat and Total Acreage of Critical Habitat Designated Within BLM-Administered Lands in the 11-State Area.[a]

State	Area of Critical Habitat (acres)		No. of Species
	For Animals	For Plants	
Arizona	367,985	31,024	21
California	226,793	24,577	43
Colorado	666,964	33,694	12
Idaho	124,869	52,360	4
Montana	131,015	—	3
Nevada	993,225	1,612	16
New Mexico	10,119	537	13
Oregon	1,239,947	2,369	16
Utah	1,571,902	5,729	15
Washington	15,872	—	5
Wyoming	56,903	357	2
Total	5,405,595	152,259	—

[a] Critical habitat totals exclude DRECP lands.

Figure 4.4-1. USFWS Critical Habitat in the 11-State Planning Area

4.4.4.2 BLM-Designated Sensitive Species

BLM Manual 6840 establishes policy for identifying and protecting sensitive species, including undertaking conservation actions for such species before they become eligible for ESA listing. In compliance with existing laws, including the BLM multiple use mission under FLPMA, the BLM shall designate Bureau sensitive species and implement measures to conserve these species and their habitats, to promote their conservation and reduce the likelihood and need for such species to be listed pursuant to the ESA.

Each BLM state director maintains a list of special status species (including BLM sensitive species). Impacts on these species would be considered in project-specific assessments before approval of any activity. The number of BLM-designated sensitive species are shown by state in Table 4.4-7. California has the greatest number of BLM sensitive species (750) and Wyoming has the least (82).

4.4.4.3 Greater Sage-Grouse Habitat Management

While not listed under the ESA, the greater sage-grouse (*C. urophasianus*) has experienced significant population declines due to habitat loss, fragmentation, and altered wildfire cycle resulting from the establishment of non-native invasive plants and human activities and development. In 2015 the BLM adopted management plans for sagebrush-steppe lands to conserve BLM-administered lands as habitat for the greater sage-grouse. Under these plans, the BLM manages 67 million acres of sage-steppe greater sage-grouse habitat with the goal of minimizing habitat loss and population declines using disturbance caps, buffers, and siting criteria. These plans also identified 29 million surface acres of BLM-administered sagebrush-steppe habitat as Priority Habitat Management Areas (PHMAs), where the management priority is to exclude or avoid disturbance to sage-grouse and their habitat, and to minimize impacts where the PHMA cannot be avoided. The plans also identified 23 million surface acres as General Habitat Management Areas, where avoidance and minimization measures are applied flexibly, in line with local conditions and a state’s science-based objectives for species management. The PHMAs in the 11-state planning area as designated in the 2015 management plans are shown in Table 4.4-8 and Figure 4.4-2. Wyoming and Nevada each have more than 10 million acres of PHMAs. California has the smallest amount of PHMA designated land, with 667,304 acres.

Since adoption of the 2015 plans, monitoring data indicate that the decline of sage-grouse populations has continued in some areas, which has reduced successful habitat conservation and restoration. The 2015 plans were amended in 2019, focusing on aligning with state management of sage-grouse habitat. However, despite recent planning efforts, sage-grouse habitat continues to be impacted and lost by public land uses. Consequently, another amendment process for the 2019 plans is underway to incorporate new sage-grouse related science and to address climate change-related habitat loss and other factors contributing to habitat loss and population declines (BLM 2023n).

Table 4.4-7. BLM-Designated Sensitive Species by Major Taxonomic Group in the 11-State Planning Area

Taxonomic Group	Arizona	California	Colorado	Idaho	Montana	New Mexico	Nevada	Oregon	Utah	Washington	Wyoming
Plant[a]	44	664	75	236	28	51	222	487	105	252	40
Fungi	—	—	—	—	—	—	—	29	—	—	—
Mollusk	5	6	—	14	—	10	85	39	—	23	—
Arthropod	3	4	—	6	2	7	117	29	2	31	—
Fish	9	6	9	24	9	15	59	27	1	9	9
Amphibian	8	10	6	4	3	2	11	9	3	5	4
Reptile	9	12	6	3	6	6	15	2	11	2	1
Bird	14	26	18	28	33	12	47	30	16	29	17
Mammal	12	22	12	28	12	8	49	14	14	18	11
Total	**104**	**750**	**126**	**343**	**93**	**111**	**605**	**666**	**152**	**369**	**82**

[a] Includes vascular and non-vascular plants (mosses and lichens).

Table 4.4-8. Total Acreage of Greater Sage-Grouse Priority Habitat Management Areas in the 11-State Area

State	PHMA (acres)[a]
California	667,304
Colorado	1,865,057
Idaho	6,018,684
Montana	9,340,415
Nevada	12,138,096
Oregon	6,629,144
Utah	5,642,597
Wyoming	15,359,314
Total	**57,660,610**

[a] Source: (Perfors 2023). Acres may be revised per the ongoing GRSG RMP amendment process.

In addition, the bi-state sage-grouse is a genetically distinct population of greater sage-grouse that lives along the California–Nevada border; it covers an area approximately 170 miles long and up to 60 miles wide. The proposed threatened status of this subpopulation along with 1.8 million acres of proposed critical habitat was recently reinstated by court ruling. Currently, the USFWS is conducting a species assessment, which will inform a final listing determination for bi-state sage-grouse (USFWS 2023e).

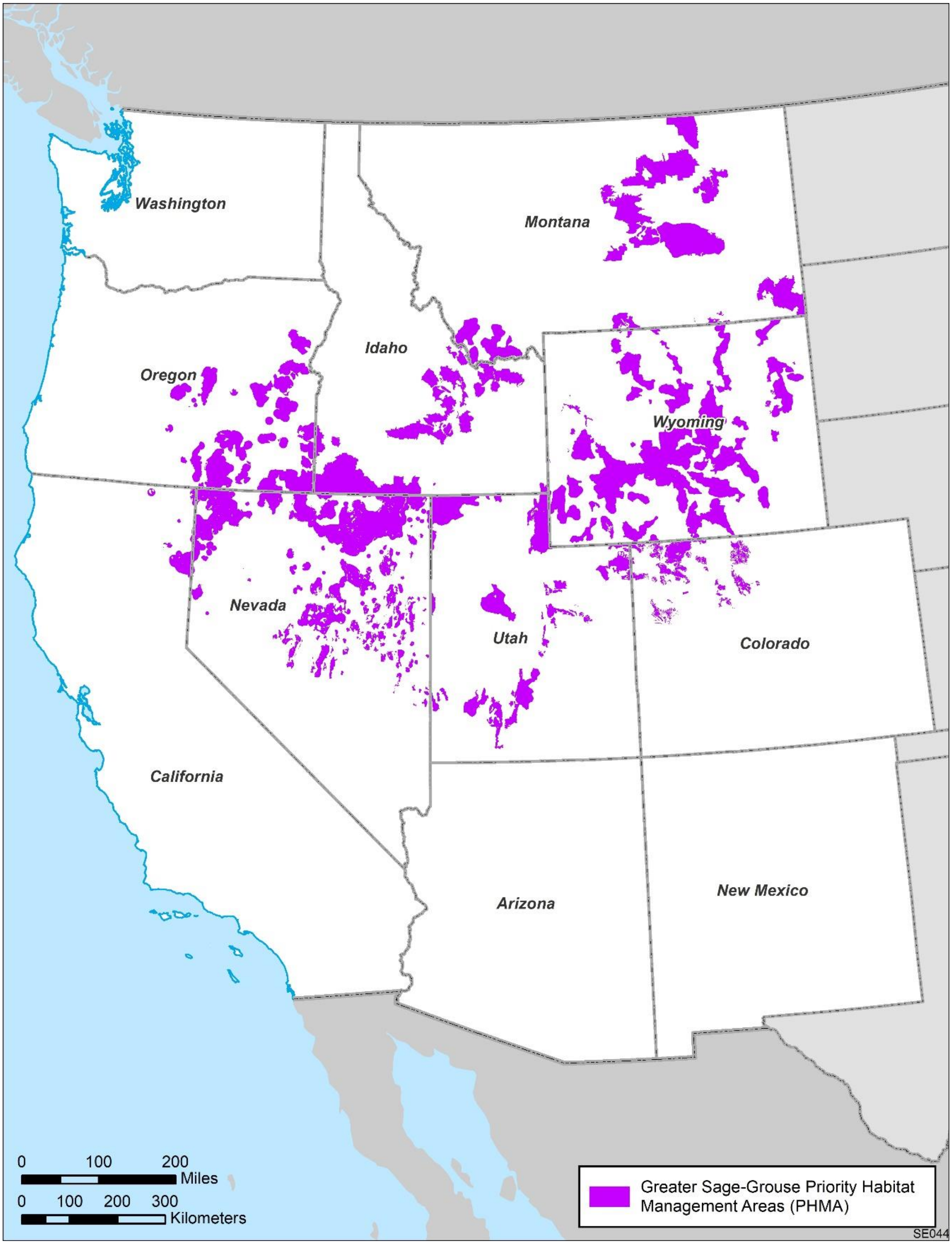


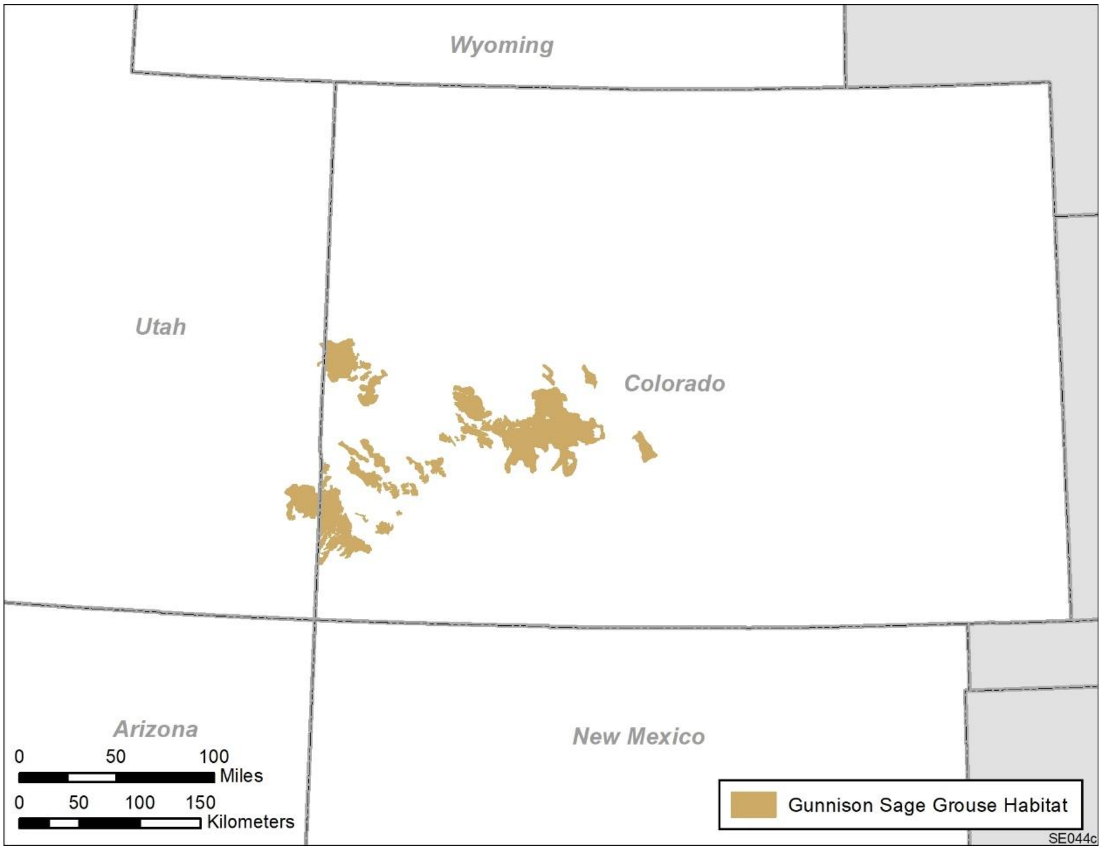
Figure 4.4-2. Greater Sage-Grouse Priority Habitat Management Areas in the 11-State Planning Area. Figure may change based on the GRSG RMP amendment process.

4.4.4.4 Gunnison Sage-Grouse Habitat Management

The Gunnison sage-grouse is an ESA-listed threatened species with eight populations in southwest Colorado and southeast Utah. Since its listing, it has continued to experience population declines due to human disturbance, the small size of existing populations, and invasive species replacing native plant communities with associated changes in fire regime. In October 2020, the USFWS released the *Final Recovery Plan for Gunnison Sage-Grouse (*Centrocercus minimus*)* for this species (USFWS 2020), and in 2022 BLM began preparing an EIS to determine whether to amend the land use plans of the BLM field offices, national monuments, and national conservation areas (NCAs) containing occupied and unoccupied habitat for Gunnison sage-grouse as identified by the USFWS in the recovery plan (USFWS 2020).

BLM manages approximately 42% of Gunnison sage-grouse occupied habitat, with the majority located across southwest Colorado (USFWS 2020). As part of the EIS planning effort, the BLM will initiate Section 7 consultation under the ESA with the USFWS on management and conservation actions identified through the planning process. Based on environmental analysis using current science and data, identification of causal factors, and public input, the BLM will formulate management actions for multiple use activities to limit impacts to Gunnison sage-grouse populations and habitat. The process will involve evaluating nine existing RMPs in Colorado and two in Utah with management areas that include Gunnison sage-grouse habitat, a total of 25.5 million acres (Figure 4.4-3).

In June 2022, the BLM provided guidance that applies to all mapped habitat, including all critical habitat (occupied and unoccupied), as designated by the USFWS, in addition to the occupied, potential, and vacant/unknown habitat categories mapped by Colorado Parks and Wildlife, across the Gunnison sage-grouse range in Colorado (BLM 2022b; Figure 4.4-3). The BLM will continue to apply conservation and mitigation measures to manage and conserve Gunnison sage-grouse and their habitat, as specified in the recovery plan for Gunnison sage-grouse (USFWS 2020).



Source: BLM (2022c).

Figure 4.4-3. Habitat Area under Consideration for the Gunnison Sage-Grouse Resource Management Plan Amendment.

4.5 Environmental Justice

As detailed in E.O. 12898, minority, low-income, and Tribal populations often experience disproportionate and adverse health and environmental burdens. The Council on Environmental Quality's report *Environmental Justice: Guidance under the National Environmental Policy Act* (CEQ 1997) describes minority, low-income, and Tribal communities and how to identify them as follows:

- Minority populations are "individual(s) who are members of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic."
- Minority populations should be identified where either (a) the minority population of the affected area exceeds 50% or (b) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.

- Low-income populations[9] in an affected area should be identified with the annual statistical poverty thresholds from the Bureau of the Census' "Current Population Reports, Series P-60 on Income and Poverty."
- "In order to determine whether a proposed action is likely to have disproportionate and adverse human health or environmental impacts on low-income populations, minority populations, or Indian Tribes, agencies should identify a geographic scale for which they will obtain demographic information on the potential impact area. Agencies may use demographic data available from the Bureau of the Census to identify the composition of the potentially affected population. Geographic distribution by race, ethnicity, and income, as well as a delineation of Tribal lands and resources, should be examined."

Several E.O.s address EJ concerns, particularly E.O. 12898, E.O. 14008, and E.O. 14096.[10] These direct all federal agencies to make achieving EJ a part of their missions by developing programs, policies, and activities to identify, analyze, and address disproportionate, cumulative, and adverse human health and environmental impacts (including risks) and hazards of federal activities.[11] These impacts include those related to climate change and the legacy of racism or other structural or systemic barriers and the accompanying economic challenges of such impacts for communities with EJ concerns. Additionally, E.O. 14096 states that EJ provides that all people have equitable access to a healthy, sustainable, and resilient environment in which to live, play, work, learn, grow, worship, and engage in cultural and subsistence practices. Identifying minority, low-income, and Tribal populations that may be disproportionately and adversely affected by decision-making processes and actions related to utility-scale solar installations is a beginning step toward avoiding, mitigating, or minimizing EJ concerns for these populations.

4.5.1 Identifying Populations with EJ Concerns

This is a broad, initial analysis solely using U.S. Census data to begin developing the information necessary to address potential EJ concerns.[12]

Using the 50% Threshold, Meaningfully Greater, and Low-Income Threshold analyses (described in Appendix F, Section F.4.5) to determine potentially affected minority and low-income populations[13] of concern is an initial step; it is expected to be followed up at

[9] BLM (2022d) defines low-income individuals as people whose income is less than or equal to 200% of the federal poverty level. BLM recommends using this definition, which is also consistent with conformance with EPA's EJScreen (https://www.epa.gov/ejscreen)..

[10] See Appendix F, Section F.4, for full-text links to E.O. 12898, E.O. 14008, and E.O. 14096.

[11] "Activities" is defined in E.O. 14096 as "rulemaking, guidance, policy, program, practice, or action that affects or has the potential to affect human health and the environment, including an agency action related to climate change."

[12] In an analysis of this scale and breadth, it is sufficient to analyze for the combined minority population. It is expected that as solar projects become more defined, a more focused and refined analysis in future EISs will include the geographic distribution by race, ethnicity, and income as well as a delineation of Tribal lands and resources.

[13] Refer to Section 4.18 for information specific to Tribal populations.

the project-level/local scale to provide more refined and relevant data from local sources, as locally sourced data, from potentially affected minority, low-income, and Tribal populations may be more accurate or current than census data and can capture non-resident populations and other place-specific information. However, this is not required for an analysis at this programmatic scale and breadth, but should this information be provided, the BLM will consider integrating it into this or future analyses. Additionally, populations potentially affected by critical mineral procurement (for the manufacturing of utility-scale PV materials) were not identified in this analysis, but it is expected that future project-level analysis will consider populations with EJ concerns who may be affected by material procurement related to utility scale PV solar energy development.

This analysis was based on CEQ (1997) guidance and BLM (2022d), Attachment 1 recommendations regarding how to identify minority and low-income populations. The analysis used the most recent 2017–2021 American Community Service (ACS) 5-Year Estimates published in December 2022 by the U.S. Census Bureau (USCB 2022b) and U.S. Current Population Reports detailed in P60-280 data tables (USCB 2023), which are summarized below (Table 4.5-1). See Section 5.5.4 for more information about potentially impacted low-income and minority populations at the block group scale within proximity to the geographic areas of each alternative.

That analysis identifies and summarizes minority (all races/ethnicities other than “white, not Hispanic or Latino”) populations in poverty, and low-income populations of potential concern for each state in the 11 western state region. Further details about the methodology used to identify these populations are provided in Appendix F, Section F.4.5).

Table 4.5-1. Composition of Identified Minority and Low-Income Populations in the 11 Western States[a]

	Total Population	Identified Minority Population (% of State Population)	Poverty Threshold (population %)	200% of Poverty Threshold (population %)
Arizona	7,079,203	46.6	12.1	24.2
California	39,455,353	64.2	11.4	22.8
Colorado	5,723,176	33.2	8.5	17
Idaho	1,811,617	19.4	8.9	17.8
Montana	1,077,978	14.9	10.7	21.4
Nevada	3,059,238	52.8	12.6	25.2
New Mexico	2,109,366	64.0	18.2	36.4
Oregon	4,207,177	25.9	9.5	19
Utah	3,231,370	22.7	7.1	14.2
Washington	7,617,364	33.5	8.3	16.6
Wyoming	576,641	17.0	8.7	17.4

Sources: USCB (2023, 2022b)

4.5.2 Equitable and Meaningful Engagement

Providing meaningful opportunities for minority, low-income, and Tribal people to engage in and influence the decisions that could impact the social, cultural, economic, or natural environment in which they live, work, recreate, or hold cultural value is expected, and required, in the effort to restore equitable share of environmental burdens and benefits.

The CEQ, which is part of the Executive Office of the President, issued *Environmental Justice: Guidance under NEPA* (CEQ 1997) to support agencies in implementing E.O. 12898 and its accompanying memorandum. This guidance recommends ways to support meaningful engagement with minority, low-income, and Tribal populations who have EJ concerns under NEPA:

- E.O. 12898 requires agencies to work to ensure effective public participation and access to information. Thus, within its NEPA process and through other appropriate guidance, each federal agency shall "wherever practicable and appropriate, translate crucial public documents, notices and hearings, relating to human health or the environment for limited English-speaking populations." In addition, each agency should work to "ensure that public documents, notices, and hearings relating to human health or the environment are concise, understandable, and readily accessible to the public."
- Each federal agency must provide opportunities for effective community participation in the NEPA process, including identifying potential impacts and mitigation measures in consultation with affected communities and improving the accessibility of public meetings, crucial documents, and notices.

As indicated in the Notice of Intent (NOI) for this project (87 FR 75284), 12 public meetings were held in the 11 western states and one in Washington, D.C. Three additional virtual meetings were held per public request to accommodate those who could not attend in person.[14] To provide information and prepare the public for the meetings, the NOI (87 FR 75284) summarized the preliminary actions, alternatives, planning criteria, and expected impacts of the proposed utility-scale solar program and then described them in more detail at the start of each public meeting. The NOI announced that special accommodations would be made, upon request, for individuals who are deaf, blind, hard of hearing, or who have a speech disability. Participation from minority, low-income, or Tribal populations with limited English proficiency was not addressed. Language translation or special accommodations that would make the information in the NOI, and meeting attendance, accessible to non-English speakers was not explicitly offered. As such, it is uncertain which, if any, minority or low-income communities may have been represented in the comments, as demographic information was not required for comment submission. Public comments were recorded, transcribed, and organized according to common categories. The public comments collected from the meetings were considered in the development of the

[14] For more information about government-to-government Tribal consultation, please refer to Section 4.18, Section 6.4, and Appendix D.

Programmatic EIS. Future public notices, documents, and meeting information and materials related to utility scale solar projects in the 11 western states should provide translations, if needed and as feasible, to accommodate local accessibility barriers experienced by minority, low-income, and Tribal populations of concern.

Project-level communication with, and inclusion of, minority, low-income, and Tribal populations will require a more intentional outreach and involvement approach to identify and address social, economic, and environmental concerns related to the project decisions and outcomes.

4.6 Geology and Soil Resources

4.6.1 Geology

4.6.1.1 Geologic Setting

The 11-state planning area encompasses several physiographic provinces, which are areas with similar terrain, rock types, and geologic structure and history (Burchfiel et al. 1992). From west to east (see Appendix F, Figure F.6-1), the physiographic provinces are (1) the Pacific Border and the Lower California provinces; (2) the Cascade-Sierra Mountains province; (3) the Northern, Middle and Southern Rocky Mountains provinces; (4) the Columbia-Snake River Plateau; (5) the Basin and Range province; (6) the Colorado Plateau; (7) the Wyoming Basin; and (8) the Great Plains province. The characteristics of these physiographic provinces are summarized in Appendix F, Table F.6-1.

4.6.1.2 Geologic Hazards

4.6.1.2.1 Seismicity

Seismic activity and related hazards, such as surface rupture, ground-shaking, and liquefaction, pose a moderate to high risk to solar energy development in some portions of the 11-state planning area. The following sections describe these hazards in terms of their probability and location in the planning area. It is important to note that the scales of the accompanying maps are small because their purpose is to show the general locations of hazardous areas (not individual faults or landslides) and how they correlate to the physiography (described in Appendix F, Table F.6-1). The risks of local seismic hazards are discussed in Section 5.6 and will be assessed more thoroughly during the site characterization phase of specific solar energy projects.

Quaternary Faults and Earthquake Activity. Quaternary faults (i.e., preexisting faults with evidence of movement or deformation within the past 1.6 million years) are thought to be the probable sources of past, current, and future earthquakes with the potential to cause damage to infrastructure. The Quaternary fault and fold database of the USGS contains information on these faults and fault-related folds, such as geologic setting, fault orientation, fault type and sense of movement, slip rate, recurrence interval, and the time of the most recent movement. The USGS database is its primary source for seismic hazards information on Quaternary faults in the United States (Machete et al. 2004).

In the 11-state planning area, Quaternary faults occur predominantly in fault zones associated with the San Andreas Fault system (western California), the Eastern California Shear Zone (eastern California), the Cascadia Fault Zone (northern California, western Oregon, western Washington), the Central Nevada Seismic Zone (west-central Nevada), the block fault systems throughout the Basin and Range province (Nevada, southern Oregon, southern Idaho), the Intermountain Seismic Belt (northern Arizona, Utah, western Wyoming, eastern Idaho, and Montana), and the Rio Grande Rift system (New Mexico and Colorado) (see Appendix F, Figure F.6-2). Historically, the most active seismic regions have been along the San Andreas Fault system and within the Eastern California Shear Zone and the Nevada Seismic Zone. Earthquake-prone areas are subject to various hazards, including surface rupture, ground-shaking, liquefaction, and landslides, that may cause severe damage to buildings and infrastructure.

Ground-Shaking. Seismic waves during an earthquake cause ground-shaking that radiates outward from the rupturing fault. Shaking intensity is mainly a function of an earthquake’s magnitude and the distance from the fault, but can be amplified by other factors, such as the softness of the ground (soft rocks and sediments versus hard rock) and the total thickness of sediments below the area. Shaking tends to be stronger in soft rocks and sediments and increases with increasing thickness of underlying sediments. Other factors affecting the pattern of shaking include the orientation of the fault, irregularities of the rupturing fault surface, and the scattering of waves as they intercept underground structures (Field et al. 2001).

The USGS’s National Seismic Hazard Map series provide estimates of likely shaking for regions throughout the United States and are used as a basis for the seismic design provisions of building codes, insurance rate structures, earthquake loss studies, retrofit priorities, and land-use planning (Peterson et al. 2020). On these maps, ground-shaking is expressed as a percentage of acceleration of a falling object due to the force of gravity (g).[15] Appendix F, Figure F.6-3, presents the peak horizontal acceleration in the six-state area as a percentage of g that has a 10% probability of being exceeded over a 50-year period. The peak horizontal acceleration ranges from 0 g (insignificant ground-shaking) to 1 g (strong ground-shaking). The highest ground-shaking hazard in the planning area occurs in coastal parts of California, Oregon, and Washington. The highest probable peak acceleration (greater than 0.40 g, or 40% of g) occurs along the trace of the San Andreas and Cascadia Fault systems. In the Basin and Range, Colorado Plateau, and Great Plains provinces to the east, the probable peak acceleration is low, in the range of 0 to 0.1 g (equal to or less than 10% of g), since seismically active areas are at some distance away. Appendix F, Table F.6-2, provides a scale that relates peak horizontal acceleration to perceived shaking and potential damage to structures on the ground.

[15] Gravity (g) is a common value of acceleration equal to 9.8 m/s^2 (the acceleration due to gravity at the earth’s surface).

Liquefaction and Landslide Susceptibility. Liquefaction refers to a sudden loss of strength and stability in loose, saturated soils, causing them to behave like a fluid. Liquefaction of soils results in ground failure of various types, including lateral spreads (landslides), flow failures, ground oscillation, and loss of bearing strength. Sand blows or boils (small eruptions) commonly accompany these types of ground failure, forming sand dikes in subsurface sediment layers and sand volcanoes at the ground surface. Liquefaction hazards occur during or immediately following large earthquakes and are associated with sandy and silty soils with low plasticity (i.e., low clay content); therefore, the potential to liquefy tends to be higher in recent deposits of fluvial, lacustrine, or eolian origin than in glacial till and older deposits. Saturated soils are more susceptible to liquefaction, and the hazards of liquefaction are most severe in near-surface soils (less than 50 ft [15 m] below the ground surface) and on slopes (SCEC 1999; Matti and Carson 1991). Steeply sloping areas underlain by loose sediment or soft rocks are most susceptible to earthquake-induced landslides. Some earthquake-prone areas in parts of California (e.g., parts of the San Francisco Bay area), Oregon (e.g., parts of the Portland Basin), and Washington (e.g., parts of the Puget Sound area) and along various inland water bodies (e.g., the shoreline of the Great Salt Lake) are highly susceptible to liquefaction (DOGAMI 2023; WADNR 2023).

4.6.1.2.2 Volcanic Activity

Major volcanoes or volcanic fields in the 11-state planning area occur primarily in California, Oregon, and Washington along the Cascade-Sierra Nevada Mountains (see Appendix F, Figure F.6-4). In California, more than 75 volcanic vents have been active during the last 10,000 years. More than 10 have erupted during the past 600 years; these include Medicine Lake, Mount Shasta, Lassen Peak, and the Mono-Inyo volcanic chain near the Long Valley Caldera. The tectonic settings of California's volcanic centers include those related to subduction in the Cascade-Sierra Nevada Mountains (Mount Shasta and Lassen Peak), crustal thinning along the Sierra Nevada escarpment (Mono-Inyo volcanic chain and Long Valley Caldera), and active crustal spreading in the Salton Sea Trough (Salton Buttes rhyolite domes; Miller 1989; Mangan et al. 2019). Other potentially active volcanoes in the planning area occur within the Southern Colorado Plateau (Uinkaret, Arizona), the Southern Rocky Mountains (Jemez Mountains, New Mexico), and the Basin and Range (Lavic Lake, California) provinces (USGS 2023a).

Active volcanoes and areas of unrest also occur in the Cascade Range in Northern California, Oregon and Washington related to subduction (Myers and Driedger 2008). Seven of these volcanoes have been active in the last 200 years: Mount Baker, Glacier Peak, Mount Rainier, and Mount St. Helens in Washington; Mount Hood in Oregon; and Mount Shasta and Lassen Peak in California. The Yellowstone volcanic field in Wyoming is very active and the volcanic-hydrothermal system of the Yellowstone region is considered one of the largest in the world. Earthquake swarms, ground deformation, and changes in hydrothermal activity have been ongoing at Yellowstone since 1980 (Diefenbach et al. 2009). No eruptions of lava or ash have occurred for thousands of years, but future eruptions are likely, though not predicted (Lowenstern et al. 2005).

The types of hazards associated with volcanism relate to the composition of material erupted and the style of eruption; therefore, the classification of volcanoes is an important part of understanding the nature of future eruptions and their potential hazards. Large, silicic central-vent volcanoes like Mount Shasta, Lassen Peak, and Mount St. Helens are expected to erupt more frequently and explosively in the future because they are located above large, shallow chambers of viscous, gas-rich magma. Mafic magma arises from greater depths (i.e., not from large chambers in the crust). Vents within mafic volcanic fields therefore tend to erupt less frequently and are less likely to occur repeatedly from the same vent. Because mafic magma is less viscous, gas can escape non-explosively (Miller 1989). Volcanic hazards include flowage phenomena, such as directed blasts, pyroclastic flows and surges; lava flows and domes, landslides and debris flows (lahars), and floods; eruption of tephra, consisting of solidified lava, pumice, ash, and rock fragments ejected high into the air that fall back to earth on and downwind from the source vent; emissions of volcanic gases, consisting mainly of steam but also CO_2; and compounds of sulfur and chlorine distributed by wind (Miller 1989; Mangan et al. 2019; USGS 2023a).

4.6.1.2.3 Mass Wasting

Landslide-Prone Areas. Landslide-prone areas are generally closely related to high, steep, rugged terrain, and a high level of precipitation. In the 11-state planning area, high landslide incidence and susceptibility are found primarily along the coasts of California, Oregon, and Washington; the Cascade-Sierra Mountain Ranges; and in the Rocky Mountain areas of Colorado, Wyoming, and Montana (see Appendix F, Figure F.6-5) (USGS 2022a, 2023a). Moderate landslide susceptibility and incidence occur adjacent to the areas of high landslide susceptibility and incidence. It is important to note that many alluvial fans near mountain ranges also have high landslide susceptibility but are not shown on the map in Appendix F, Figure F.6-5 because of the map’s small scale. Fan deposits are common in the alluvial basins throughout the planning area.

Debris Flows. A debris flow is a fast-moving mass of water with high sediment (from clay to boulder size) and debris (trees and brush) content capable of causing extensive damage to structures in its path with little or no warning. Debris flows are associated with younger (active) alluvial fans, which are cone- to fan-shaped landforms that commonly occur along the range fronts bordering alluvial basins. The behavior and path of a debris flow will depend on its sediment content and speed and on characteristics of the alluvial fan, such as soil and vegetation cover, slope, and fan type and degree of development. Debris flow hazards are greatest during heavy or sustained rainfall events and on steep fan slopes with available sediments and rocks (due to minimal vegetation cover). They also may be accompanied by flash floods (Larsen et al. 2001; National Research Council 1991; Meyer and Berger 1992; FEMA 1989).

Although rare, debris flows present significant hazards. These hazards include abrasion of objects and structures in the flow path, burial of objects and structures where debris is deposited, and erosion that occurs along the flow path—all with significant changes to the landscape (Katzer and Schroer 1986). The paths of future debris flows are not easy to predict since flows are subject to sudden relocation, even during a single event

(FEMA 1989); however, geomorphological mapping of alluvial surfaces using the distribution patterns of soil development, desert pavement, and rock varnish to delineate active (and transient) parts of alluvial fans holds promise for flood-hazard assessment (Field and Pearthree 1997; Bedford and Miller 2010). Mitigation strategies to protect land from the hazards of debris flows involve building large structural controls (e.g., check dams) and avoiding construction on active alluvial fan surfaces (Larsen et al. 2001).

4.6.1.2.4 Land Subsidence

Land subsidence is a form of ground failure that occurs as the gradual settling or sudden collapse of the ground surface due to loss of subsurface support. Its cause is attributable to various human activities and natural processes, including withdrawal of underground fluids (groundwater, petroleum, and geothermal fluids), dewatering of organic soils, underground mining, wetting of dry, low-density sediments (hydrocompaction), natural compaction, dissolution of soluble sedimentary rocks (sinkholes), liquefaction, crustal deformation, and thawing permafrost (Galloway et al. 1999; National Research Council 1991). In the 11-state planning area (especially in alluvial basins), the most likely cause of subsidence is aquifer compaction as a result of groundwater withdrawal.

Alluvial basins are important sources of groundwater, especially for agricultural irrigation. When groundwater is over-pumped, water levels in the underlying aquifer decline, causing a decrease in the fluid pressures that normally support the weight of overburden. If the aquifer material is compressible, loss of pore volume (or compaction) occurs over a wide region, causing a permanent reduction in the total storage capacity of the aquifer system and land subsidence (National Research Council 1991; Galloway et al. 1999). In the 11-state planning area, subsidence has been reported in numerous basins in California, Nevada, Idaho, Arizona, Colorado, and New Mexico (see Appendix F, Table F.6-3).

The types of hazards associated with land subsidence caused by groundwater withdrawal include flooding (due to reductions in ground elevation in flood-prone areas, e.g., Centennial Wash near Wendon, Arizona); earth fissures (Harquahala Plain, Arizona); differential vertical subsidence (due to variations in thickness of underlying compressible deposits; e.g., Las Vegas Valley); and horizontal displacement (Burbey 2002).

4.6.2 Soil Resources

4.6.2.1 Soil Taxonomy

Soil formation results from the complex interactions between parent (geologic) material, climate, topography, vegetation, organisms, and time. The classification of soils is based on their degree of development into distinct layers or horizons and their dominant physical and chemical properties. For the purpose of this report, soils in the 11-state planning area are described according to their soil order, the highest category of soil taxonomy used by the Natural Resources Conservation Service (NRCS 1999). The nine soil orders within the planning area, their distribution, and general characteristics are described in Appendix F, Table F.6-4, in order of decreasing predominance. A map of the dominant soil orders within the planning area is provided in Appendix F, Figure F.6-6.

4.6.2.2 Erosion of Soils

Soils within the 11-state planning area may be vulnerable to erosion by water and wind. Rainfall intensity, runoff velocity (influenced by slope length and gradient as well as by surface roughness), soil moisture, and soil texture are key factors affecting susceptibility to erosion. Factors that function to stabilize soils include vegetation cover, biological soil crust cover, rock cover, high salt or calcium carbonate content, high clay and silt content, physical crusts (e.g., gypsite or playa efflorescent crusts), and desert pavement. The potential for erosion is increased when soil surfaces are disturbed by agricultural or construction activities, vehicle activity, and the trampling effects of wildlife, livestock, and humans. Loss of soil fines due to erosion reduces the soil's productivity because most plant-essential nutrients are bound to fine particles near the surface and because the loss of the fine particles also reduces the soil's water-holding capacity. Once waterborne or airborne (as fugitive dust), soil particles are a nonpoint source of pollution with potentially significant ecological and health impacts. Deposition of eroded soil fines may also be problematic when it reduces the fertility of plants and biological soil crusts (by burial of photosynthetic components) and contributes to sedimentation in surface water bodies. Because soil formation by weathering of parent rock is a slow process, often taking thousands of years, and dust deposition is low in most regions (except in areas near large dust sources), the replacement of lost soil is also very slow (Belnap et al. 2007). Therefore, the best mitigation to reduce soil loss by water or wind erosion is to follow practices that avoid soil disturbance and control the loss of soil to the maximum extent possible.

Appendix F, Figure F.6-7, shows the susceptibility of surface soils in the 11-state planning area to erosion by water and by wind. The erodibility factor for water quantifies the susceptibility of soil detachment by runoff and raindrop impact (USDA 2023); larger numbers indicate soils that are more susceptible to erosion by water. The erodibility index for wind quantifies the susceptibility of soil detachment and transport by wind (USDA 2023); larger numbers indicate soils that are more susceptible to erosion by wind. Indicators of soil susceptibility to erosion by wind and water are also included in the BLM AIM terrestrial indicators dataset (TerrADat; BLM 2023).

4.6.2.3 Biological Soil Crusts

Biological soil crusts are composed of complex communities of cyanobacteria, green algae, bryophytes, lichens, mosses, microfungi, and other bacteria (Weber et al. 2016; Rosentreter et al. 2007). The filaments produced by these organisms weave through the top few millimeters of soil, forming a matrix that stabilizes and protects soil surfaces from wind and water erosion and retains soil moisture (Belnap and Büdel 2016). They also contribute carbon to the underlying soils and increase the bioavailability of nutrients such as nitrogen and phosphorus. As a result, biological soil crusts play an important role in establishing and supporting native vegetation.

Biological soil crusts are commonly found in semiarid and arid environments, such as those throughout the 11-state planning area. They occur on all types of soils, especially in areas where vegetation is widely spaced. Indicators of bare soil cover and gaps between plant canopies are included in the BLM AIM TerrADat dataset (BLM 2023). The composition of biological soil crusts varies with soil pH and salinity; for example, green algae favor acidic soils with low salt content, while cyanobacteria favor alkaline soils with high salt content. The cover of lichens and mosses is greater in soils with high clay and silt content (except on clay soils with high shrink-swell potential) and in moist habitats (Rosentreter et al. 2007). Scientists have experienced some success in characterizing biological soil crusts using satellite and aerial sensing (Rozenstein and Adamowski 2017; Havrilla et al. 2020). Attributes included in the BLM AIM TerrADat dataset (BLM 2023) have been correlated with the abundance of biological soil crusts (Condon and Pyke 2020), which may be useful in predicting the presence of biological soil crusts in unsurveyed areas.

Biological soil crusts are highly susceptible to disturbance (Zaady et al. 2016), especially in sandy soils. Disturbance can affect their composition (e.g., intense disturbance favors the growth of cyanobacteria but not lichens) and reduce the number of crust organisms found on the surface. Because well-developed biological soil crusts are more resistant to erosion (Belnap and Büdel 2016) than thinner cyanobacterial crusts, in areas where biological soil crusts are disturbed by agricultural or non-agricultural activities the rate of soil loss due to surface runoff or wind erosion is likely to increase.

4.6.2.4 Desert Pavement

Desert pavement is a type of surface armor that forms on the ground in hot desert environments, such as those covering the southern portion of the 11-state planning area. Desert pavements consist of a thin layer of closely packed, angular to sub-rounded coarse rock fragments and are associated with alluvial fans and other unsorted alluvial deposits (Ritter 1986). They typically occur on surfaces with very little relief and lie above a gravel-free layer of well-developed soil; their exposed surface is often characterized by a dark and shiny coating or varnish of minerals (e.g., iron oxide) and organic carbon (McFadden et al. 1987). The abundance of coarse particles on desert pavements is thought to be the result of deflation, a process whereby fine sediments are eroded from alluvium by wind or water, and the upward movement of larger clasts through the alluvial matrix by cycles of shrinking/swelling or freezing/thawing until they reach the surface (Ritter 1986). Other investigators have observed well-developed desert pavements in volcanic terrains where eolian silt and fine sand have filled the voids between clasts of basaltic colluvium (e.g., Cima volcanic field) and scoria (e.g., Amargosa Desert; McFadden et al. 1987; Valentine and Harrington 2005).

Desert pavements are less susceptible to disturbance than biological soil crusts, but once they are disturbed, desert pavements lose their armoring function, increasing the likelihood of soil loss due to surface runoff or wind erosion.

4.6.2.5 Farmland Classification

Farmland is a valuable resource that provides local, statewide, and national benefits by supporting productive agriculture. The Farmland Protection Policy Act (FPPA) (7 U.S.C. § 420l)(1)) and its implementing regulations (7 C.F.R. § 658.2(a)) are intended to minimize the irreversible conversion of farmland (and potentially productive land not currently being farmed) to non-agricultural uses. These protections apply to projects that are completed by, or with assistance from, a federal agency. The Natural Resources Conservation Service identifies important farmlands based on soil quality, growing season, and an adequate and dependable water supply (including from irrigation) (10 CFR 657.5). Prime farmland is land with the best combination of characteristics for crop production. Unique farmland is non-prime farmland that is nonetheless used to produce certain high-value crops. Farmland of statewide and local importance are other lands that are specified by state or local agencies as important for agricultural production. A map of the farmland classification for the 11-state planning area is shown in Appendix F, Figure F.6-8.

4.7 Hazardous Materials and Waste

Waste and hazardous materials may exist in small quantities in isolated locations on land identified for solar energy development as a result of illegal dumping and/or accidental release of substances associated with current land uses, such as hydrocarbons and off-highway vehicle use. Waste and hazardous materials may exist in larger quantities where historical uses involved mining operations or military uses. That said, the land identified for solar energy development, for all practical purposes, is expected to be free of waste and hazardous materials in any significant quantities.

The following sections discuss the types and estimate the quantities of wastes and hazardous materials associated with the construction, operation, and decommissioning of a solar energy facility. Component manufacturing or assembly facilities are not within the scope of this assessment and are not addressed. Wastes from facilities that support the solar energy facility by supplying necessary chemicals and materials to support operations, or by providing treatment and disposal of facility-related wastes, are also not addressed.

4.7.1 Construction

Wastes associated with the construction of renewable energy facilities would be similar to wastes resulting from the construction of any large industrial facility. Wastes are likely to include both hazardous and nonhazardous industrial solid wastes as well as nonhazardous domestic solid wastes and both industrial and sanitary wastewaters.

Hazardous materials associated with the construction of solar energy facilities would be generally similar in nature to the hazardous materials associated with construction of any major industrial facility. Potentially hazardous industrial solid wastes might include wastes resulting from the use of compressed gases, spent vehicle and equipment fluids and components (e.g., used oil, used hydraulic fluids, spent filters, oily rags and wipes, and spent Pb acid or nickel-Cd batteries and battery electrolyte), listed solvents and corrosion control coatings, and hazardous materials containers that do not meet the federal or state regulatory definition of “empty.” Table F.7-1 (in Appendix F) lists the major types of hazardous materials expected to be present onsite during the construction phase.

All such hazardous waste is expected to be generated in limited quantities and would likely be accumulated in portable containers of 55-gal (210-L) capacity or less onsite for brief periods before being transported by a registered transporter to offsite permitted hazardous waste treatment, storage, or disposal facilities. Energy recovery or recycling opportunities also may be identified for some hazardous industrial wastes.

Nonhazardous industrial solid wastes would include waste packaging and dunnage (scrap wood, steel, glass, plastic, paper, and empty metal containers) as well as excess concrete, broken equipment, or components. Recycling or energy recovery opportunities may exist for some of this material, provided adequate segregation is practiced. Otherwise, disposal of all such wastes would likely be in properly permitted offsite landfills.

Nonhazardous domestic solid wastes would be generated as a result of onsite administrative activities and in support of the workforce and would primarily include such materials typically found in office waste streams, including wastepaper and food scraps. All such wastes are expected to be containerized until removal by local solid waste contractors to permitted sanitary landfills or recycling centers (when such options exist).

Industrial wastewaters resulting from equipment and component cleaning and system purging activities would be containerized and transported to properly permitted wastewater treatment or disposal facilities. Plumbing and system components that would contain fluids are also expected to undergo one-time hydrostatic testing for system integrity once assembly is completed. The wastewaters from such tests may contain small amounts of contaminants from system assembly, and some may also exhibit hazardous characteristics. Other wastewaters may include stormwater contaminated with sediment, which would be managed in accordance with a stormwater pollution prevention permit, and excavation dewatering waste streams that may be allowed to be discharged to surface drainage in the absence of contamination or allowed to evaporate in lined on-site impoundments. Water from dewatering operations may also be used for control of fugitive dust on unpaved access and onsite roads. If onsite wells were installed to supply water for industrial processes, some small amounts of well development fluids and borehole cuttings would be produced. Drilling muds are likely to be captured in temporary lined impoundments near the drilling site and ultimately recovered for reuse. Drill cuttings would likely be disposed of on the surface in areas adjacent to the wells (provided no prior contamination was encountered). Small amounts of wastewater from equipment washing associated with concrete production are likely to be produced if an onsite concrete batching plant is used. Such wastewaters would typically be discharged to the ground surface. Sanitary wastewaters resulting from workforce support may either be containerized in portable facilities before being removed to offsite sewage treatment facilities or disposed of on-site in septic systems under the auspices of appropriate permits when local soil and subsurface conditions allow.

4.7.2 Operations

Wastes related to the cleaning and maintenance of major PV system components and support equipment include spent solvents and aqueous cleaning solutions, spent oils, hydraulic fluids, and coolants, and wastes typical of building maintenance as well as domestic solid wastes from administrative activities and sanitary wastewaters associated with workforce support.

The amounts and variety of hazardous materials present onsite during operations can vary greatly and would depend on numerous factors, including the size and power-producing capacity of the facility and the remoteness of the facility's location from commercial suppliers. The water used for washing PV panels needs to be demineralized water which, in most cases, would require some onsite water treatment capability, probably involving ion-exchange resins or reverse osmosis. Also, PV facilities can be expected to have dielectric fluids (mineral oils and/or SF_6 gas) contained in electrical equipment. Table F.7-2 (Appendix F) displays the major hazardous materials present in PV facilities.

Routine operation of a PV facility should result in only limited solar panel waste from malfunctions or damage sustained in accidents or as a result of weather extremes. In those instances, if the integrity of the panel is compromised, semiconductor material containing hazardous components may be released and would have to be managed as hazardous waste. The potential release of Cd and other heavy metals from broken modules (especially Cd telluride, copper-indium-diselenide [CIS], and copper-indium gallium selenide) constituted an area of early concern for PV facility development (Nieuwlaar and Alsema 1997; EPRI and CEC 2003; Fthenakis and Zweibel 2003). However, such accidental releases are isolated and release small amounts of metals to the underlying soils. Damaged or broken panels would need to be containerized and characterized for proper disposal (or could possibly be recycled), and areas surrounding their installed locations surveyed and remediated, if necessary, to remove any toxic metal contamination. In general, PV solar energy facilities result in decreases in emissions of Cd, mercury, and other heavy metals because they replace fossil fuel sources that emit large quantities of these substances (Turney and Fthenakis 2011).

4.7.3 Decommissioning Wastes

Decommissioning of a facility, whether premature or at the end of the facility's planned active life, would be addressed in detail in an approved closure plan. Approved decommissioning is expected to include complete dismantlement of the facility and recycling of the individual equipment and components to the greatest extent practical. Equipment laydown areas established initially for facility construction may be reactivated during decommissioning to provide for interim storage of equipment and components awaiting recycling. Fluids removed from equipment would be characterized to determine appropriate disposal or evaluated for potential reuse. In either case, containerization and brief onsite storage would occur before ultimate disposition. Some pieces of equipment (e.g., large electrical equipment containing dielectric fluids), although recyclable, may need to be emptied of fluids before being moved; however, the fluids removed may be reintroduced into the equipment after evaluation for quality and contamination when that equipment is put into service at a different location. After emptying, components would be purged and cleaned with appropriate cleaning agents, and the resulting wastes characterized and disposed of in offsite facilities. Wastes associated with component cleaning and dismantlement include preventive maintenance wastes for the various construction equipment employed during decommissioning. Decommissioning wastes would also include contaminated soils and spent absorption media resulting from recovery and remediation of spills and leaks that occurred during facility operation or as a result of dismantlement activities. Such wastes would be containerized and characterized for disposal in appropriately permitted offsite facilities. Road-building materials (sand gravel, clean fill) and removed concrete foundations and pads would be stockpiled for recycling, most likely for road building or fill operations elsewhere.

It is reasonable to expect that buried components would be removed to sufficient depths to facilitate revegetation of the site in accordance with a BLM-approved revegetation plan. Components at greater depths may be cleaned (when necessary) and abandoned in place. Buried pipes would be evacuated and cleaned and pipe segments capped before abandonment in place.

If lined surface impoundments are used during operation, remaining liquids, accumulated sludge, and any synthetic liner materials would be removed, containerized, and characterized for proper disposal, and the impoundment area re-graded with indigenous soils.

Special care must be exercised in the disposal of PV panels composed of high-performance solar cell materials that contain toxic metals (Fthenakis and Zweibel 2003; EPRI and CEC 2003). Metal components were found to be released from buried solar panels under typical landfill conditions (Su et al. 2019), so large volumes of used solar panels going to landfills at end of life (EOL) is a concern for potential future soil and groundwater contamination. Ideally, used solar panels would be dismantled and delivered intact to offsite recycling facilities where the hazardous constituents would be removed and reprocessed. However, currently EOL PV modules are generally stored in warehouses or sent to landfills in the United States (Curtis et al. 2021). As solar deployment increases in the United States and globally, it is critical that viable strategies for repair, reuse, and recycling of solar panels be developed and supported (Heath et al. 2022). Developing a viable repair, reuse, and recycling industry for PV solar panels would alleviate environmental and human health concerns and create jobs, including for underserved populations (Health et al. 2022).

4.8 Health and Safety

Potential human health and safety issues related to solar energy projects are summarized in this section (and discussed in greater detail in Section 5.8). Section 4.8 also discusses physical hazards to workers; potential safety and health issues for the general public; and the potential for elevated exposures to electromagnetic fields (EMFs).

4.8.1 Occupational Hazards

Occupational health and safety programs associated with construction, operations, and decommissioning of solar energy facilities and associated transmission lines are regulated under the federal Occupational Safety and Health Act (29 U.S.C. 651 et seq.). A special consideration at solar energy facilities would be protection of vision from potentially damaging glare from the solar field; this would be addressed in the facility's health and safety plan. Occupational noise exposure standards for workers must comply with the regulatory requirements of 29 CFR 1910.95. The states may have additional laws and regulations that build on that law. Workers at any solar energy facility are subject to risks of injuries and fatalities from physical hazards. These occupational hazards can be minimized when workers adhere to safety standards and use appropriate protective equipment. However, fatalities and injuries from on-the-job accidents can still occur; detailed project-specific health and safety plans and adequate worker training would minimize the likelihood of occurrence.

Most of the occupational hazards associated with solar energy projects are similar to those of the heavy construction and electric power industries. Additional hazards are associated with the fact that many construction activities would take place outdoors in remote locations. Accident rates have been tabulated for most types of work, and risks can be calculated on the basis of historical industry-wide statistics. The National Safety Council (NSC) maintains statistics on the annual number of injuries and fatalities by industry type (NSC 2006). The expected annual number of worker fatalities and injuries for specific industry types can be calculated on the basis of NSC rate data and the number of annual full-time equivalent workers required for construction and operations activities at a solar energy project (see Section 5.8). Under certain conditions, the risk of occupational heat stress or stroke is likely to be high during construction of solar energy facilities and associated transmission lines. Health and safety plans will need to address this risk. Chemical exposures during construction and operation of a typical solar energy project are expected to be routine and minimal, and can be mitigated, if needed, by using personal protective equipment (PPE) and/or engineering controls to comply with OSHA permissible exposure limits and other accredited exposure limits (U.S. Department of Labor 2023) that are applicable for construction activities.

At PV facilities, infrequent damage to solar panels could result in the accidental release of small quantities of hazardous metal compounds to the ground surface. Cleanup procedures for these accidental releases would require the use of PPE; thus, actual worker exposures to these substances would be low.

4.8.2 Public Safety

Physical Hazards. A potential public safety issue is unauthorized or illegal access to solar energy facilities. During such unauthorized access, individuals could disturb electrical equipment (e.g., attempt to open electrical panels, which could result in electrocution) or encounter other hazards. Such access is generally minimized through the common use of fencing around the entire sites of PV solar energy facilities, but it may still occur occasionally.

Fire Risks. The risk of fires at PV solar energy facilities can be increased by the presence of dry vegetation, high winds, and/or invasive plant species (introduced by initial clearing of the sites during construction); and the use of flammable substances and internal and external combustion engines onsite. Some reasons fires could be started include electrical shorts, insufficient equipment maintenance, contact with power lines, or lightning. The clearing of native vegetation that is subsequently replaced by invasive species in a ROW can increase the risks of both initiation and spread of fires. However, clearing and maintaining a ROW can also result in the creation of a man-made firebreak. Clearing mainline ROWs and certain functional areas, such as electrical substations and pump and compressor stations for operational safety can also reduce the amount of fuel available within the ROW for fires. Fire risks might increase because of the presence of certain structures associated with transmission lines. Tall electricity transmission towers represent an increased potential for lightning strikes (however, standard practice would require that all such structures be grounded). Ground faults or arcing from energized electricity conductors and substation equipment also represent increased potential for fire.

Transmission lines and their support towers could represent obstacles to safe staging of firefighting equipment (including air tankers). However, maintenance access roads along transmission lines often provide critical access points for effective firefighting. Because smoke increases the conductivity of the air, smoke from wildfires can cause flashover between conductors. Damage to towers or power conductors due to exposure to intense heat from an adjacent fire could cause wholesale failure of the transmission system, involving electrical arcing to ground that would jeopardize firefighting personnel and equipment in the immediate vicinity. For this reason, high-voltage lines near active wildfires are often de-energized. Firefighting personnel also face increased risk of electrocution where high-voltage lines are present, and toxicity hazards from inhalation of gases such as SO_2 and hydrogen fluoride that may be emitted from burning solar panels (Liao et al. 2020). In general, the risk to the public posed by inhalation of smoke from fires at PV solar energy facilities is low because the facilities are located away from residences. Data on fires at utility-scale solar energy facilities are lacking, though there have been a few news reports on grassland fires near solar energy facilities that were quickly extinguished and caused little damage (Bellini 2022; *Paso Robles Daily News* 2023).

4.8.3 Electric and Magnetic Fields

When current flows through transmission lines, magnetic fields are generated. There is a potential risk from exposure to the magnetic fields from transmission lines carrying electricity from PV solar energy facilities to the transmission grid. These magnetic fields rapidly decrease in strength with distance from the source. For example, for a single-circuit 500-kV lattice structure transmission line, the magnetic field strength is about 250 milliGauss (mG) directly under the line, decreases to about 25 mG at 38 m (125 ft) distance from the centerline, and to less than 10 mG at 61 m (200 ft) from the centerline (Stokes and Funkhouser 2018). Public exposures to magnetic fields associated with PV solar energy facilities are low because of the low magnetic field strength at the edge of transmission line ROWs and required setback zones from homes and occupied buildings. Additional information about potential health impacts associated with magnetic fields is presented in Section 5.8.

4.9 Lands and Realty

The BLM administers just about 173 million surface acres of land (700,000 km^2) in the 11 western states (BLM 2023p). These lands, generally known as “public lands,” are often intermingled with other federal, state, Tribal, or private lands. The BLM also administers nearly 713 million acres (2.89 million km^2) of subsurface mineral estate; some of these mineral estates underlie the BLM-managed lands mentioned above, some underlie lands administered by other federal agencies, and some underlie state, Tribal, or private lands (BLM 2023p).[16] Table 4.9-1 lists the total surface acreage of the 11-state planning area, and- the acreages of all federal lands and BLM-administered lands.

The BLM-administered Lands, Realty and Cadastral Survey program facilitates commercial, recreational, and conservation activities to ensure that the BLM-administered lands are working landscapes managed for the use and enjoyment of current and future generations. This mission encompasses a wide range of BLM-administered land transactions such as purchases and acquisitions, sales and exchanges, and withdrawals (BLM 2023p). Table 4.9-2 lists the changes to BLM-administered lands in FY 2022. Leases, permits, and ROWs support energy development and energy transmission, roads, film production and other economic activities. The Cadastral Survey Program surveys and marks Federal interest land boundaries and facilitate the BLM management of land boundaries (BLM 2023q).

[16] Unless specifically noted, references to BLM-administered lands are for surface only and do not include mineral estates.

Table 4.9-1. Area and Percentage of BLM-Administered Lands in the 11-State Planning Area

State	Total State Area (acres[a])	Federal Surface Land Area (acres[a])	BLM-Administered Lands (acres[a])	BLM-Administered Lands (% of Total State Area)
Arizona	72,688,000	28,077,992	12,078,435	16.62
California	100,206,720	45,493,133	14,983,333[b]	14.95
Colorado	66,485,760	24,100,247	8,354,714	12.57
Idaho	52,933,120	32,789,648	11,775,071	22.25
Montana	93,271,040	27,082,401	8,044,336	8.62
Nevada	70,264,320	56,262,610	47,273,840	67.28
New Mexico	77,766,400	24,665,774	13,491,852	17.35
Oregon	61,598,720	32,244,257	15,709,417	25.50
Utah	52,696,960	33,267,621	22,759,263	42.97
Washington	42,693,760	12,192,855	450,385	1.05
Wyoming	62,343,040	29,137,722	18,047,278	28.95
Total	**752,947,840**	**345,314,260**	**172,967,924**	**22.97**

[a] To convert acres to km^2, multiply by 0.004047.
[b] 10,818,000 acres are within the DRECP, and would not be subject to solar energy development.
Sources: BLM (2016a, 2023p); Congressional Research Service (2020).

Table 4.9-2. Acreage Change to BLM-Administered Lands in the 11-State Area, FY 2022[a]

State	Acquisitions/ Exchanges/ Donations[b]	Disposal/ Sales[c]	Withdrawn/ Reserved[d]	Total Decrease[e]	Net Change[f]
Arizona	2,831	1,112	0	1,112	1,719
California	434	0	0	0	434
Colorado	647	0	0	0	647
Idaho	1,829	1	0	1	1,828
Montana	0	0	2,688	2,688	(2,688)
Nevada	0	203	0	203	(203)
New Mexico	0	20	0	20	(20)
Oregon	1,280	0	0	0	1,280
Utah	87	7,368	3,050,000	3,057,368	(3,057,281)
Washington	236	0	0	0	236
Wyoming	0	1	0	1	(1)
Total	**7,344**	**8,705**	**3,052,688**	**3,061,393**	**(3,054,049)**

[a] To convert to hectares, multiply by 0.4047.
[b] Lands obtained by BLM through purchase, donation, or exchange.
[c] Lands that have been disposed of or sold by BLM are conveyed under various public land laws or by an act of Congress.
[d] These lands are withdrawn, modified, or reserved and designated for a specific public purpose by a proclamation, E.O., secretarial order, act of Congress, or public land order.
[e] Total acres removed from BLM's jurisdiction (sum of disposal/sales and withdrawn/reserved).
[f] Positive or negative change from FY 2021 to FY 2022 (negative numbers are displayed in parentheses.
Source: BLM (2023p).

FLPMA, as amended, enables BLM to accomplish a variety of lands management actions, including but not limited to sales, withdrawals, acquisitions, exchanges, leases, permits, easements, and granting ROWs. The Lands, Realty, and Cadastral Survey Programs generally address three distinct segments of these management actions:

land use authorizations, land tenure (the transfer of land ownership or land interests through purchases, donations, sales, and exchanges), and management of land boundaries (land surveys, standards for boundary evidence certificates, and public land survey system dataset.

4.9.1 BLM-Administered Land Management Actions

The BLM has a longstanding commitment to make lands available for authorized private sector activities, such as recreation, energy and mineral commodity extraction, livestock forage use, sawtimber harvest, and other related land use authorizations and land dispositions (FLPMA, as amended). A BLM-administered land use authorization permits an applicant to use a specific piece of public land for a certain project or use (e.g., fil, permits). BLM transfers land ownership via acquisition obtained through purchase, donation, exchange, or condemnation or via conveyances through sales, exchanges, and by other authorized actions resulting in a patent or deed such as a Recreation and Public Purposes Act conveyance. Administrative jurisdiction of federal land may be transferred via withdrawal (BLM 2023r). Land tenure decisions, described in most RMPs, are done to consolidate or otherwise promote the efficient management of BLM-administered land resources, protect and improve valuable wildlife habitat, enhance recreational opportunities, and provide access to public lands.

Land use is managed within a framework of numerous laws, the most comprehensive of which is FLPMA. On BLM-administered lands, land use is governed by various land use plans including RMPs and RMP amendments. The RMPs typically establish goals, objectives, and standards that apply to the lands and resources managed under the plans. To ensure the best balance between resource use and resource protection for BLM-administered lands, BLM undertakes extensive land use planning through a collaborative approach with local, state, and Tribal governments; the general public; and stakeholder groups (BLM and Western 2015). RMPs and the decisions they promulgate are the basis for every on-the-ground action the agency undertakes. BLM-administered lands that are not designated for special management must be managed under the principles of multiple use and sustained yield (FLPMA, as amended).

The BLM’s general policy is to facilitate environmentally responsible commercial development of solar energy projects on BLM-administered. In accordance with FLPMA, Section 103(c), BLM-administered lands are to be managed for multiple uses that take into account the long-term needs of future generations for renewable and non-renewable resources. The Secretary of the Interior is authorized to grant ROWs on public lands for systems of generation, transmission, and distribution of electric energy (FLPMA, Section 501(a)(4)).

4.9.2 BLM Programmatic Decisions and Actions

Land use and land management is closely associated with the multiple resource uses and sustained yield of diverse natural resources occurring within BLM-administered lands. Most land use topics have been addressed in other sections of this Programmatic EIS, including cultural resources, ecology, fire and fuels, mining and mineral resources, livestock grazing, wild horses and burros, recreation, visual resources, Tribal interests, and special land designations. Other important uses of BLM-administered lands include use for utility corridor ROWs and ROWs for renewable energy facilities.

A ROW is an authorization to place facilities over, on, under, or through BLM-administered lands for construction, operation, maintenance, or termination of a project. ROW authorizations include such uses as roads, water pipelines, natural gas pipelines, powerlines, telephone lines, fiber optic cables, railroads, canals, ditches, and communication sites (FLPMA, as amended). Section 503 of FLPMA provides for the designation of ROW corridors and encourages use of ROW co-location to minimize environmental impacts and the proliferation of separate ROWs. Solar energy projects are initially granted for up to 30 years (plus the initial partial year of lease; 43 CFR 2801.9(d)(3) and (4)). Competitive leases in DLAs are fixed for 30 years plus partial year. However, the BLM has proposed a rule extending this period to 50 years for solar (and wind) developments (88 FR 39726).

Section 368 of the Energy Policy Act of 2005 directed the secretaries of the U.S. Department of Agriculture (USDA), U.S. Department of Commerce, U.S. Department of Defense (DOD), and DOI to designate corridors for electricity transmission and oil, gas, and hydrogen pipelines on federal land in 11 western states. To meet this mandate, in 2008 the DOE and the BLM published the Westwide Energy Corridor Final PEIS (DOE and BLM 2008), and the BLM issued an Approved Resource Management Plan Amendments and ROD designating 5,002 miles (8,050 km) of Section 368 energy corridors on BLM-administered lands in the 11 states (BLM 2009). Subsequently, the BLM also conducted regional reviews of the Section 368 corridors to examine new relevant information and stakeholder input (BLM et al. 2022). In accordance with the Energy Act of 2020, the DOI supports onshore renewable energy through BLM's administration of public lands.

Wind, solar, and geothermal resources are the leading renewable energy resources with the potential for development on BLM-administered lands. Wind and solar on BLM-administered lands are processed through the lands and realty program as ROW actions; geothermal resources, considered a fluid leasable mineral, are processed through the fluid minerals program according to the provisions of the Mineral Leasing Act of 1920, as amended. Beginning in 2003, BLM became involved in a series of environmental reviews for renewable energy development in the western United States. The over4-67veralbjective of these reviews was to expedite the amendment of individual RMPs for renewable energy development. A Programmatic EIS and ROD for wind energy development was completed in 2005 (BLM 2005b,c), a Programmatic EIS and ROD for leasing geothermal resources was completed in 2008 (BLM 2008d; BLM and USFS 2008), and a Programmatic EIS and ROD for solar energy development was completed in 2012 (BLM 2012a; BLM and DOE 2012). These decisions established agency-wide policies and procedures for processing renewable energy applications. They also included stipulations and/or best-management practices to minimize environmental impacts.

4.10 Military and Civilian Aviation

Several thousand public, private, and military airports; heliports; seaplane bases; and ultralight flightparks occur within the 11-state planning area (Table 4.10-1). The BLM's National Aviation Office is responsible for aircraft operation support for wildland and prescribed fires, disaster response, animal censuses, wild horse and burro gathers and aerial surveys, habitat management, range surveys, cadastral surveys, law enforcement, forest management, photo mapping, search and rescue, and other uses related to BLM-administered land and resource management missions. The aircraft are BLM-owned, contracted, and are call-when-needed or on an aircraft rental agreement to fill BLM's mission requirements (BLM 2023s).

Table 4.10-1. Airports, Heliports, Seaplane Bases, and Ultralight Flightparks Within the 11 Western States

State	Military Use	Public Use	Private Use	Heliports	Seaplane Bases	Ultralight Flightparks	Total
Arizona	7	77	102	107	0	5	**298**
California	22	242	214	378	2	1	**859**
Colorado	4	74	182	181	0	1	**442**
Idaho	1	125	127	50	1	1	**305**
Montana	1	123	131	40	1	1	**297**
Nevada	5	49	49	55	0	1	**159**
New Mexico	3	60	66	34	0	1	**164**
Oregon	0	102	224	92	1	1	**420**
Utah	2	46	40	72	0	0	**160**
Washington	6	119	208	164	7	3	**507**
Wyoming	1	42	51	24	0	0	**118**
Total	**52**	**1,059**	**1,394**	**1,197**	**12**	**15**	**3,729**

Source: AirNav, LLC (2023).

All BLM aviation support facilities are constructed, maintained, and operated in compliance with applicable regulations/direction of DOI, BLM, Federal Aviation Administration (FAA), Occupational Safety and Health Administration (OSHA), and lease agreements. BLM's permanent and temporary airbases are managed by district or field offices. Permanent airbases support heavy air tanker and single-engine air tanker retardant bases, and airplane and helibase/heliport facilities with permanent or temporary fixtures that are used on a continuous or seasonal basis. These aircraft bases include government-owned or leased aviation facilities on federal or non-federal land where BLM has primary responsibility for operations, maintenance, and oversight. Temporary bases are sites used on a temporary or intermittent basis (i.e., helibases, heliports, unimproved landing areas, and remote airstrips). Temporary operations bases are those used to support short-term projects and wildland fire. These bases can be located on federal, state, local government, or private land. Sites not located on BLM-administered land must be preapproved by the landowner and appropriate BLM management (BLM 2023t).

Many military training routes (MTRs) and special use airspace (SUA) are used by the military and other agencies in the 11-state planning area. Their specific locations and operational needs must be considered when siting utility-scale solar energy facilities and related transmission facilities. Rather than just being individual routes or training areas, military airspace forms a complex system that supports military testing, training, and operations from military flight crews from all parts of the western United States. This interconnected system represents an important national defense asset.

The U.S. military uses airspace for its testing, training, and operations, some of which occur at low altitudes (from 1,000 ft [305 m] to as low as ground surface). The National Aeronautics and Space Administration uses military airspace near Edwards Air Force Base to support some of its operations, and civilian military aircraft contractors also use military airspace to support their test programs. Airspace restrictions for MTRs and SUAs (SUAs also include military operating areas) cover about 37% of the public land in the western states. Public lands overlain by MTRs and SUAs are found throughout the 11-state planning area, with New Mexico and California having the largest amount of coverage. Figures F.10-1 through F.10-4 (Appendix F, Section F.10.2) show the extent of military airspace restrictions at altitudes of 1,000 ft (305 m) or less within the 11-state planning area. Solar energy development in proximity to these training areas would require consultation with the DOD Clearinghouse during project planning to ensure that solar projects do not conflict with DOD training activities.

The presence of civilian airports and their operational airspaces also must be considered when siting utility-scale solar energy facilities and related transmission facilities.

4.11 Mineral Resources

Energy and mineral resources are among the highest economic commodities among commercial uses for surface lands and subsurface estates administered by the BLM. Table F.11-1 (Appendix F, Section F.11.2) provides information on mineral acreage administered by BLM within the 11-state planning area. BLM’s minerals program consists of three categories: saleable, leasable, and locatable. Saleable minerals (also referred to as mineral materials) are subject to the Materials Act of 1947. They include basic natural resources such as sand, gravel, pumice, cinder, soil, and common varieties of stone and clay. These materials are sold to the public, on request, at fair market value or can also be provided to federal, state, and local government agencies at no cost through free use permits. Also, a limited amount may be provided free to non-profit groups. Leasable minerals, subject to the Mineral Leasing Act of 1920, include energy resources (e.g., oil, gas, oil shale, coal, and geothermal) and non-energy resources (e.g., sodium, phosphate, potassium, gilsonite, and sulfur). Locatable minerals are appropriated by the public under the General Mining Law of 1872, as amended. Locatable (hardrock) minerals include, but are not limited to, precious and base metals (e.g., gold, silver, Pb, zinc, manganese, and copper), fissionable products (e.g., uranium), and nonmetallic materials (e.g., gemstones, fluorspar, and mica). Tables F.11-2 through F.11- 8 (Appendix F, Section F.11.2) provide information on mineral leases, contracts, permits, and production in the 11-state planning area for FY 2022.

It is BLM's policy to make mineral materials available to the public and governmental agencies whenever possible and wherever environmentally acceptable. Disposal of mineral materials is a discretionary action and will be authorized in accordance with appropriate laws, regulations, and policies, in conformance with an approved RMP. Through the land use planning process, the BLM may identify specific terms and conditions applicable to developing mineral resources in specific areas or in some instances may recommend that the mineral estate not be available for development because of the presence of other important resource values (DOE and BLM 2010).

IM 2023-036 (BLM 2023u) provides Inflation Reduction Act conditions for issuing ROWs for solar or wind development. Section 50265 of the Act provides that the BLM may not issue ROW authorizations for solar or wind energy development unless it has (1) held an onshore oil and gas lease sale during the 120-day period before the issuance, and (2) the sum total of acres offered for lease in onshore lease sales during the 1-year period ending on the date of the ROW issuance is not less than the lesser of 2,000,000 acres (8,094 km^2) or 50% of the acreage for which Expressions of Interest for oil and gas leasing have been submitted during that period.

4.12 Paleontological Resources

Paleontological resources include fossilized remains, imprints, and traces of plants and animals preserved in certain types of rocks and sediments. Usually, these rocks and sediments develop over centuries as sedimentary rock. However, paleontological material is occasionally found in metamorphic or volcanic rocks as well. While greater focus is on the often-rarer vertebrate fossils (dinosaurs, fish, mastodon, etc.), many invertebrate and plant fossils are also rare. The rarity of such specimens and fossil assemblages and the unique information that can be gleaned from these items emphasize their scientific value and the need to protect them. The area considered in this Programmatic EIS is extensive, including lands in 11 western states; therefore, there is a potential for paleontological resources ranging from individual finds to full assemblages to be present in the geological formations within these areas.

On public lands, paleontological resources are governed by a variety of statutes, regulations, and policies. The Paleontological Resources Preservation Act of 2009

- Establishes that:
    - Paleontological resources collected under a permit are U.S. property and must be available for scientific research and public education and preserved in an approved facility;
    - The nature and location of paleontological resources must be kept confidential to protect those resources from theft and vandalism; and
    - Theft and vandalism of paleontological resources on public lands can result in civil and criminal penalties, including fines and/or imprisonment.

- Requires that the agency:
    - Manage paleontological resources using scientific principles and expertise;
    - Develop a program to inventory paleontological resources on public lands; and
    - Establish an education program to increase public awareness about paleontological resources.

The law also mandates the development of management plans for inventory, monitoring, and scientific and educational use of paleontological resources. These plans will also emphasize interagency coordination and collaboration where possible with non-federal partners, the scientific community, and the public (BLM 2022g).

Additional statutes for management and protection include FLPMA and 18 U.S.C. Part 641, which establishes penalties for the theft and destruction of government property, including paleontological resources. Other federal acts, such as the Federal Cave Resources Protection Act (codified at 16 U.S.C. 4301), protect fossils found in significant caves.

Due to the large number of fossils and fossil-bearing geological formations in the American West, BLM developed guidance focused on the classification of geological formations based on likelihood and type of fossilized material to be discovered known as the Potential Fossil Yield Classification (PFYC) system (see BLM 2022f), described in Appendix F, Section F.12. The BLM also looks to the most recent best practices for determining the impact on paleontological resources on BLM-administered lands with a focus on qualifications, land ownership, field data collection, business ethics, and other practices for managing paleontological resources (Murphey et al. 2019).

Further information such as best practices, lists of geological formation types, detailed descriptions of the PFYC scale, and other resources specific to paleontological resource assessments, such as maps, can be found in Appendix F, Section F.12.

4.13 Rangeland Resources

4.13.1 Livestock Grazing

Livestock grazing is a major and widespread use of public lands. The BLM currently manages livestock grazing on 155 million of the 175 million acres of BLM-administered land in the 11-state planning area. Grazing that occurs on BLM-administered lands is authorized either through a grazing permit or lease. As of January 2022, 17,367 grazing authorizations (permits and leases) were in force for BLM-administered lands in the 11-state planning area (BLM 2023p). The number of authorizations and the associated authorized use varies by state (see Appendix F.13.1.2.

The terms and conditions for grazing on BLM-managed lands (such as livestock numbers and season of use) are set forth in the permits and leases issued by the BLM to public land ranchers (BLM 2023v). Permits and leases generally cover a ten-year period and are renewable, with modifications to the terms and conditions if conditions warrant. The amount of grazing that takes place each year on BLM-administered lands can be affected by such factors as drought, wildfire, and market conditions.

Livestock grazing on BLM-administered lands is often tied to base property and/or water rights that are privately owned. The value of an individual's ranching operation is linked to the value of the AUMs of forage authorized under the federal grazing permit, the value of a permittee's interest in range improvements, in some cases the value of water rights attached to grazing use, and the value of the private lands associated with the grazing permit. Reductions in the forage allocated in the grazing permit affect the overall value of the ranching operation, including the value of the associated private lands.

4.13.2 Wild Horses and Burros

The Wild Free-Roaming Horses and Burros Act of 1971, as amended, gave BLM the responsibility to protect, manage, and control wild horses and burros (WH&B). Under this Act, WH&B are considered an integral part of the national system of BLM-administered lands in the areas where they were found in 1971. These areas are classified as herd areas (HAs). BLM Handbook H-4700-1 (BLM 2010c) and Manual 4700 (BLM 2010d) describe the authorities, objectives, policies, and procedures that guide the management of WH&B on BLM-administered lands. The general management objectives for WH&B are to (1) protect, maintain, and control healthy herds with diverse age structures while retaining their free-roaming nature; (2) provide adequate habitat for WH&B through the principles of multiple use on BLM-administered lands; (3) achieve and maintain a thriving natural ecological balance with other resources; (4) provide opportunities for the public to view WH&B; and (5) protect WH&B from unauthorized capture, branding, harassment, or death (BLM 2010c,d; DOE and BLM 2008). To achieve this goal, the BLM designated HMAs for the long-term maintenance of WH&B herds and collects data about the animals and their habitat (BLM 2010c).

Habitat for WH&B is composed of four essential components: forage, water, cover, and space. These components must be present within the HMA in sufficient amounts to sustain healthy WH&B populations and healthy rangelands over the long term (BLM 2010c,d), known as the AML. AMLs include an upper and lower limit that apply to the number of adult WH&B to be managed within the population. The AML upper limit is established as the maximum number of WH&B above which rangeland damage could occur, while the AML lower limit establishes a number that allows the population to grow (at the annual population growth rate) to the upper limit over a period of three to five years (BLM 2010c,d; DOE and BLM 2008). WH&B that are found outside of HMAs are considered excess and are subject to removal (BLM 2010c,d; DOE and BLM 2008). The WH&B high- end AML for the western states is 23,866 horses and 2,919 burros, but the estimated WH&B population is 68,928 horses and 13,955 burros, giving an overall excess WH&B estimate of 56,098. Of the 177 HMAs in the western states, only 25 are at AMLs (BLM 2023w).

Herd population management is important for balancing herd numbers with forage resources and with other uses of the public and adjacent private lands. BLM Manual 4710 (BLM 2010e) includes information on the control and disposition of WH&B on BLM-administered lands and on other lands that are adjacent to or intermingled with public land and serve as habitat for WH&B; BLM Manual 4720 (BLM 2010f) describes the authorities, objectives, and policies that guide the removal of excess WH&B from the BLM-administered lands and other lands that are adjacent to or intermingled with public land. The BLM manages populations in each of the HMAs toward AMLs through WH&B population growth suppression, gathers, and removals. These gathers are conducted as necessary, with an optimal frequency of once every three to four years. Extenuating circumstances such as drought, high reproduction rates, and poor range condition, budgets, and holding capacities can alter the frequency of the gathers (BLM 2019e). Since the WH&B adoption program began in 1973, the three legal means of disposing of excess gathered animals have been through public adoptions, sales, and euthanasia. Euthanasia has not been used for population control since the late 1980s; however, sick, and lame horses can be euthanized for humane purposes (BLM 2019e). Constraints and threats to WH&B management include, but are not limited to, conflict with energy development; competition with wildlife and livestock; overpopulation; habitat loss (rangeland damage); forage and water availability; illegal chasing, capturing, and harassment; and range improvements (fences) that restrict their free-roaming nature (BLM 2019e).

WH&B herd size varies depending on food availability, environmental conditions, and other factors. The basic wild horse herd usually consists of an alpha male who remains close by in the breeding season; five or six unrelated females with young of different ages; and groups of bachelor or solitary males. Typical wild horse herd sizes will have 5 to 11 mares and 1 to 4 stallions in addition to offspring, but can have up to 26 mares, 5 stallions, and various ages of pre-dispersed young (Bennett and Hoffmann 1999; Clement 2015). Annual home range usually is less than 25 km^2 (6,178 acres) but can be as high as 300 km^2 (74,100 acres; NatureServe 2023a). Herd size and home range are positively correlated. There are seasonal movements and variations in home range typically associated with seasonal precipitation changes, food availability, temperatures, and topography (Clement 2015).

Wild burros have an average home range of about 32 km^2 (7,900 acres) but can be as low as 4 km^2 (988 acres) to as high as 97 km^2 (23,970 acres; NatureServe 20223b; Pagan 2022). They can range 4 to 6 km (2.5 to 3.8 miles) from water (Grinder et al. 2006). Social organization of wild burros varies from solitary individuals, small groups, large groups, and herds. Small groups usually consist of a single male with a few females or are all male or all female adults. Large groups have one or more males and up to 10 females; some large groups consist solely of females. Herds consist of 25% males and the rest females and their young. No permanent groups exist, except small groups of young animals, 2–3 years old, with their mother. Large herds occasionally form during the day to feed but break up again in the evening (Grinder et al. 2006).

Within BLM-administered lands in 10 of the 11 western states (there are no WH&B HAs or HMAs in Washington), HAs total 42,440,065 acres (171,749 km^2) and HMAs total 26,917,766 acres (108,932 km^2) (BLM 2023w). Table F.13.2-1 (Appendix F, Section F.13.2.2) summarizes the WH&B statistics for each western state, while Figure F.13.2-1 (Appendix F, Section F.13.2.2) shows the HAs and HMAs within the western states.

4.14 Recreation

Most of the American public's interaction with BLM-administered lands is through outdoor recreation activities. In FY 2022, more than 81 million recreation-related visits occurred on public lands in the 11-state planning area (Appendix F, Table F.14-1). Recreation on BLM-administered lands includes a wide range of activities (Appendix F, Table F.14-2).

Approximately 62% of recreational activities on public lands occur within areas that have been specially designated, such as National Conservation Lands (formerly known as the National Landscape System), and Special Recreation Management Areas. Special designations are explained in greater detail in Section 4.16 and are shown in Figures 4.16-1 through 4.16-4.

The remaining 38% of recreational activities occur on public lands with no special designation. Uses (including recreational activities) of public lands outside a specially designated area are governed by a broader multiple-use mandate, which provides for multiple co-existing uses that respond to America's needs for recreation, energy, food, fiber, timber, minerals, and ecological services. Decisions about what combination of uses are permitted on any given tract of otherwise unencumbered public land are guided by land-use plans and federal regulation.

4.15 Socioeconomics

The socioeconomic environment potentially affected by the development of solar resources on federal land includes 11 states, the area within which solar project construction and operations workers would spend their wages and salaries, and the location of many of the vendors that would supply materials, equipment, and services under the No Action and Action Alternatives. In the following sections, eight key socioeconomic measures are described: population, employment and unemployment, personal and median household income, low-income communities, housing, state sales and income tax revenues, state and local government expenditures, and state and local government employment. To avoid any bias associated with including data from 2020, when the majority of effects from COVID were experienced, data presented from 2021 for employment, unemployment, income, housing, state and local government expenditures and employment are averages for the period 2017 to 2021. Data for low-income communities are based on income data from 2019.

4.15.1 Population

Total population in the 11 states in 2020 stood at 76.4 million in 2020, and is expected to reach 83.3 million by 2030 (Arizona Commerce Authority 2023), California Department of Finance 2023), Colorado Department of Local Affairs 2023), Idaho Department of Labor 2023), Montana Department of Commerce 2023), Nevada Department of Taxation 2023), University of New Mexico 2023), Portland State University 2023), U.S. Census Bureau 2023a,b,c), University of Utah 2023), Washington Office of Financial Management 2023), Wyoming Department of Administration and Information 2023) (Appendix F, Table F.15.2-1).[17] Population in the region is concentrated in California which, at 39.5 million, had almost 52% of total population in the 11 states in 2020. California's population is expected to increase to 41.9 million by 2030. With the exception of Arizona (7.2 million), Colorado (5.8 million), and Washington (7.7 million), each of the remaining states had a population of less than 5 million in 2020. While the population in Arizona, California, Colorado, Nevada, Oregon, Utah, and Washington is more concentrated in urban areas, population elsewhere in the 11 states is distributed more evenly, with larger rural populations in Montana (44.1% of the total), Wyoming (35.2%), Idaho (29.4%), and New Mexico (22.6%).

Population in the 11 states grew at an annual average rate of 0.9% between 2010 and 2020. Growth within the region was fairly uneven over the period, with higher annual growth rates in Utah (1.7%), Idaho (1.6%), Nevada (1.4%), Colorado (1.4%), and Washington (1.4%). Growth rates in Arizona (1.1%), Montana (0.9%), and Oregon (1.0%) were closer to the average for the region, with lower than average rates in California (0.6%), New Mexico (0.3%), and Wyoming (0.2%).

4.15.2 Employment and Unemployment

More than 36 million people were employed in the 11 states in 2021 (the latest year for which data were available), and 2.3 million were unemployed (U.S. Census Bureau 2023d). Almost 52% (18.7 million) of all employment in the 11 states (36.2 million) was concentrated in California (Appendix F, Table F.15.2-2). Employment in Arizona, Colorado, and Washington stood at 3.2 million, 3.0 million, and 3.7 million, respectively; the remaining states supported less than 2.5 million jobs.

Unemployment rates in 2021 in Nevada (7.1%), New Mexico (6.6%), and California (6.5%) were slightly higher than elsewhere in the 11 states (Appendix F, Table F.15.2-2). With the exception of California, relatively small labor forces exist in each state, although fairly large numbers of workers are currently unemployed in several of the states that could be available to work on future proposed solar energy developments.

Almost 19 million people in the 11 states were employed in service industries (52.3%) in 2021, with smaller numbers employed in wholesale and retail trade (13.4%),

[17] There are differences between U.S. Census and ACS data relating to place of residence at the time data are collected, and consequent minor inaccuracies occur in data on both migrant workforces and summer residencies in rural areas. Therefore, to provide more accurate population statistics, data from the 2020 Census were used instead of 2021 ACS data.

manufacturing (8.5%), and construction (7.0%) (U.S. Census Bureau 2023e) (Appendix F, Table F.15.2-3). The largest difference in the distribution of employment across sectors in the 11 states is in agriculture, which is more important in Montana (4.8% of total employment) and Idaho (4.1% of the total) than in the other nine states. Mining employment in Wyoming (6.9%) is also more important than elsewhere in the 11 states.

4.15.3 Income

California generated almost 56% of personal income, more than $3 trillion, in the 11 states in 2021 (U.S. Department of Commerce 2023) (Appendix F, Table F.15.2-4), followed by Washington ($589 billion), Colorado ($433 billion), and Arizona ($417 billion). Median household incomes were highest in California ($84,097), Washington ($82,400), and Colorado ($80,184), and lowest in New Mexico ($54,020).

A large number of communities in each of the 11 states can be designated as low-income in 2020 (Appendix F, Table F.15.2-5). These are cities or places where individuals with annual incomes that are up to 200% of the federal poverty level make up 50% or more of the population, or where the low-income population, as defined, is 100% or greater than the corresponding county low-income population. These communities are concentrated in California, with large numbers also in Washington, Colorado, Oregon, and Montana.

4.15.4 Housing

The 11-state region as a whole had 29.7 million housing units in 2021, including 16.3 million owner-occupied, 10.7 million rental units, and almost 2.7 million vacant units (U.S. Department of Commerce 2023f) (Appendix F, Table F.15.2-6). California has the largest number of housing units in the 11-state region, with more than 7 million owner occupied units, almost 6 million rental units, and more than 1 million vacant rental units. Vacancy rates vary across the 11 states, from 9.0% of owner-occupied units in both Colorado and Idaho to less than 1% in Utah and Washington. Vacancy rates for rental units varied from 10.8% in Wyoming to less than 4.0% in California (3.9%), Oregon (3.6%), and Washington (3.9%).

4.15.5 Tax Revenues

California generated 48.1% of sales tax revenues ($57.8 million) in the 11-state region in 2021, 67.4% of state individual income tax revenues ($100.1 million), and 79.8% of corporate income taxes ($13.8 million) (U.S Bureau of the Census 2023g) (Appendix F, Table F.15.2-7). Washington generated the next largest sales tax revenues at $23.1 million, followed by $12.0 million in Arizona. Oregon does not impose a sales tax. With the exception of California and Idaho, individual income tax revenues are less than $10 million in each state. Corporate income tax collections are also much smaller outside California, with only Oregon collecting more than $1 million in 2021. Nevada, Washington, and Wyoming have neither individual nor corporate income taxes.

4.15.6 State and Local Government Revenues and Expenditures

Revenues collected to support state and local government services are largest in California, at $530.1 million in 2019 (the last data year available before COVID-related shortfalls in 2020) (U.S Bureau of the Census 2023g). California government expenditures are also large relative to the other states, at $644.2 million spent in 2019, representing more than 60% of all government expenditures in the 11-state region (Appendix F, Table F.15.2-8). Other states with fairly large state and local government revenue and expenditures were Arizona ($58.5 million in revenues, $66.6 million in expenditures), Colorado ($58.5 million and $66.6 million), and Washington ($85.4 million and $100.7 million). Revenues in the 11-state region were $898 million in 2019, supporting expenditures of $1.0657 billion.

4.15.7 State and Local Government Employment

Almost 51% of state and local government employment in the 11-state region in 2021 (3.6 million) was in California (1.8 million) (U.S Bureau of the Census 2023g) (Appendix F, Table F.15.2-9). Other states with fairly large government employment were Arizona (279,186), Colorado (310,490), and Washington (386,327). Levels of service (number of employees per thousand of state population) for state and local governments varied across the 11 states, with lower levels in Arizona (39.4) and Nevada (37.2), and higher levels in Wyoming (86.6), compared to a level of service in the 11 states as a whole of 47.6. There was less variation in the levels of service for uniformed police officers and firefighters across the 11 states, with slightly lower levels for police officers in California, higher in Wyoming. There were higher levels of service for firefighters in Arizona, Colorado, and Washington, and lower levels in Montana and Wyoming. In contrast, variation in the level of service for teachers was much wider across the 11 states, with higher levels in Colorado, Montana, Idaho, New Mexico, and Wyoming, and lower levels in Arizona, California, and Washington.

4.16 Specially Designated Areas and Lands with Wilderness Characteristics

4.16.1 National Conservation Lands

Specially designated areas include areas that have received recognition or designation because they possess unique or important resource values. In June 2000, the BLM responded to growing concern over the loss of open space by creating National Conservation Lands (NCLs; see BLM undated g).[18] This national system of public lands gained legal permanence in 2009 with the passage of the Omnibus Public Land Management Act (BLM 2012d). The NCL system was established to provide a national framework for managing Congressionally and Presidentially designated special management areas on public lands, including those to be administered for conservation purposes. The NCL mission is to conserve, protect, and restore nationally significant

[18] The NCL was formerly known as the National Landscape Conservation System.

landscapes recognized for their outstanding cultural, ecological, and scientific values (BLM 2012d). Components of the NCL include NCAs, national monuments, wilderness areas, wilderness study areas (WSAs), NHTs, national scenic trails (NSTs), and wild and scenic rivers (WSRs; BLM undated g).

4.16.1.1 National Conservation Areas (NCAs)

NCAs are designated by Congress and managed by the BLM to conserve, protect, restore, and enhance America's natural and cultural resources, while allowing for compatible multiple uses. They may also be established to protect a variety of ecological, scenic, scientific, riparian, and recreation values. There is no single congressional act that guides the management of these areas. Instead, each specific Act that authorizes designation of a NCA identifies the unique values to be protected and any other specific management guidelines to be followed (BLM and USFS 2008).

Table F.16-1 (Appendix F, Section F.16.2) summarizes the NCAs within the 11-state planning area, while Figures F.16.2-1 through F.16.2-4 show their locations within BLM-administered lands.

4.16.1.2 National Monuments

BLM Manual 6220, *National Monuments, National Conservation Areas, and Similar Designations* (BLM 2017g), includes guidance on managing BLM-administered lands that have been designated by Congress or the President as national monuments. These areas are managed to conserve, protect, restore, and enhance America's national and cultural heritage while allowing for compatible multiple uses. National monuments provide opportunities for hunting, solitude, wildlife viewing, fishing, history exploration, scientific research, and a wide range of traditional uses. They are home to threatened and endangered plant and animal species, significant cultural and paleontological resources, critical migration corridors for wildlife, and access to world-class hunting and fishing areas.

Table F.16.2-2 (Appendix F, Section F.16.2) summarizes the national monuments within the 11-state planning area, while Figures F.16.2-1 through F.16.2-4 show their locations within BLM-administered lands. Table F.12.2-1 (Appendix F, Section F.12.2) lists the national monuments with paleontological components.

4.16.1.3 Wilderness Areas

The Wilderness Act of 1964, as amended, defines wilderness as an area of undeveloped federal land retaining its primeval character and influence, without permanent improvements or human habitation, and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least 5,000 acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.

The general policies for the administration and management of BLM wilderness areas, designated by Congress, are provided in BLM Manual 6340, *Management of Designated Wilderness Areas* (BLM 2012e). Wilderness areas are to be managed and administered to preserve the wilderness character of the area. Wilderness character is composed of the following qualities: untrammeled; natural; undeveloped; solitude or primitive and unconfined recreation; and unique, supplemental, or other features (BLM 2012e). Except as otherwise provided in the Wilderness Act, wilderness areas shall be devoted to the public purposes of recreational, scenic, scientific, educational, conservation, and historical use (BLM 2012e). The BLM's objectives for managing wilderness areas are to (BLM 2012e):

- Manage and protect BLM wilderness areas in such a manner as to preserve wilderness character;
- Manage wilderness for the public purposes of recreational, scenic, scientific, education, conservation, and historic use while preserving wilderness character; and
- Effectively manage uses permitted under SectioI4(c) and 4(d) of the Wilderness Act of 1964 while preserving wilderness character.

Table F.16.2-3 (Appendix F, Section F.16.2) summarizes the wilderness areas within the 11-state planning area, while Figures F.16.2-1 through F.16.2-4 show their locations of wilderness areas within BLM-administered lands.

4.16.1.4 Wilderness Study Areas (WSAs)

WSAs are areas with wilderness characteristics identified and recommended through the inventory and study processes authorized by Section 603 of FLPMA, as amended. BLM Manual 6330 provides information for BLM's management of WSAs (BLM 2012f). WSAs and the unique features and ecosystems they contain are to be protected until such time that Congress acts to designate WSAs as wilderness areas, or releases them from further consideration. WSAs that are released by Congress would be managed under general BLM management authorities found in FLPMA and associated regulations and policies, including applicable land-use plans (BLM 2012f). WSAs must be managed in a manner that would not impair the suitability of the area for preservation as wilderness and to prevent unnecessary or undue degradation. Except for grandfathered uses and valid existing rights, permitted activities in WSAs are temporary uses that create no new surface disturbance and do not involve placement of permanent structures.

WSAs often have special qualities, such as ecological, geological, educational, historical, scientific, and scenic values, and must possess the following characteristics (BLM 2012f):

- Size—Roadless areas of at least 5,000 contiguous acres of public land or of manageable size.
- Naturalness—Generally appear to have been affected primarily by the forces of nature (unaffected by manmade influences).
- Solitude and/or primitive and unconfined recreation—Provide outstanding opportunities for solitude or primitive and unconfined types of recreation.

Table F.16.2-4 (Appendix F, Section F.16.2) summarizes the WSAs in the 11-state planning area, while Figures F.16.2-1 through F.16.2-4 show their locations within BLM-administered lands.

4.16.1.5 National Historic Trails (NHTs) and National Scenic Trails (NSTs)

NHTs and NSTs are authorized and designated only by an act of Congress under the National Trails System Act of 1968, as amended. The purpose of this act is to accommodate the outdoor recreation needs of an increasing population while preserving the environment, history, and natural aesthetics of open areas. BLM Manual 6250 (BLM 2012g) provides policy and program guidance on administering congressionally designated NHTs and NSTs as assigned by the DOI within the NCL system and this manual describes the BLM’s roles, responsibilities, agency interrelationships, and policy requirements for National Trail administrators.

The National Trails System (which includes NHTs, NSTs, national recreation trails, and connecting and side trails) is designated to allow outdoor recreation opportunities; protect nationally significant scenic, historic, natural, or cultural qualities of areas; and represent desert, marsh, grassland, mountain, canyon, river, forest, and other areas, as well as landforms that are characteristic of a region (BLM 2012h). NHTs are extended long-distance trails, not necessarily managed as continuous, that follow as closely as possible the original trails or routes of travel with national historical significance, and have as their purpose the identification and protection of the historic route and its historic remnants and artifacts for public use and enjoyment (BLM 2012h).

NSTs are continuous, primarily nonmotorized routes of outstanding recreation opportunity (BLM 2012h). They are established to provide maximum outdoor recreation potential, and for the conservation and enjoyment of the nationally significant scenic, historic, natural, or cultural qualities of the areas through which such trails may pass. They may be located so as to represent the landform characteristics of the physiographic regions of the nation (BLM 2012h).

BLM Manual 6280 (BLM 2012h) identifies requirements for managing trails undergoing a National Trail Feasibility Study; trails that are recommended as suitable for National Trail designation through the National Trail Feasibility Study; inventory, planning, management, and monitoring of designated NSTs and NHTs; and data and records management requirements for NSTs and NHTs. National recreation trails provide a variety of outdoor recreation uses in or reasonably accessible to urban areas, while connecting or side trails provide additional points of public access to national recreation trails, NSTs, or NHTs, or which will provide connections between such trails. BLM Manual 8353 (BLM 2012i) identifies requirements for managing these trails.

Table F.16.2-5 (Appendix F, Section F.16.2) summarizes NHTs and NSTs within the 11-state planning area; Figures F.16.2-1 through F.16.2-4 show their locations within BLM-administered lands.

4.16.1.6 Wild and Scenic Rivers (WSRs)

Congress established the National Wild and Scenic Rivers System in 1968 through the Wild and Scenic Rivers Act. To be considered a WSR, rivers or river segments must have a free-flowing condition and possess at least one outstandingly remarkable value, such as scenic, recreational, geologic, fish, wildlife, historic, cultural, or other features. The BLM has many rivers not congressionally designated under the act, but found to be eligible under the act. After a river segment has been studied and found to be eligible, a suitability determination is then made under a subsequent land use planning decision. The outstandingly remarkable values of suitable rivers must be protected until superseded by Congress. BLM Manual 6400 (BLM 2012j) provides policy, direction, and guidance for the identification, evaluation, planning, and management of eligible and suitable WSRs and the management of designated components of the National Wild and Scenic Rivers System.

Within the National Wild and Scenic Rivers System, three classifications define the general character of designated rivers: wild, scenic, or recreational. Wild rivers or river segments are free of impoundments and generally inaccessible except by trails, with watersheds or shorelines essentially primitive and waters unpolluted. Scenic rivers or river segments are free of impoundments, with shorelines or watersheds still largely undeveloped but accessible in places by roads. Recreational rivers or river segments are readily accessible by road or railroad; may have some development along their shorelines; and may have undergone some impoundments or diversion in the past. These classifications are used to help develop management goals for the river (BLM 2012j). These classifications also control the level of development that may occur within a stream corridor once a stream is determined eligible or suitable and a classification is assigned.

Table F.16.2-6 (Appendix F, Section F.16.2) summarizes the WSRs within the 11-state planning area, while Figures F.16.2-1 through F.16.2-4 show their locations within BLM-administered lands.

4.16.2 Other Special Designations

Other special designations within BLM-administered lands include ACECs (BLM undated h), byways (national scenic and back country byways; BLM undated i), and LWCs (BLM undated j). Although those areas are not units of the NCL, they are included here for convenience.

4.16.2.1 ACECs

An ACEC is defined in FLPMA, Section 103(a), as an area within BLM-administered lands where special management attention is needed to protect one or more of the following relevant and important values of the area from irreparable damage:

- Historic, cultural, paleontological, and scenic values including but not limited to rare or sensitive archeological resources and religious or cultural resources important to Native Americans;
- Fish and wildlife resources including but not limited to habitat for endangered, sensitive, or threatened species, or habitat essential for maintaining species diversity; and/or
- A natural process or system including but not limited to endangered, sensitive, or threatened plant species; rare, endemic, or relict plants or plant communities that are terrestrial, aquatic, or riparian; or rare geological features.

Designation and management of ACECs advance the multiple use and sustained yield goals in FLPMA. ACECs can also be designated to protect human life and safety from natural hazards including but not limited to areas of avalanche, dangerous flooding, landslides, unstable soils, seismic activity, or dangerous cliffs. BLM Manual 1613 (BLM 1988b) provides policy and procedural guidance on the identification, evaluation, and designation of ACECs; clarifies the relationship of ACECs to other designations; and provides guidance on ACEC monitoring and management. An ACEC designation is not used as a substitute for wilderness suitability recommendations (BLM 1988b). ACEC Manual 1613 (MS-1613, rel. 1-1541) is under revision. Until the revised manual is published, the policy clarifications and guidance found in Information Memorandum IM-2023-013 (BLM 2023y) are being used, in conjunction with applicable law, regulation, and the existing MS-1613 policy, to guide the designation and management of ACECs.

Table F.16.2-7 (Appendix F, Section F.16.2) summarizes the ACECs within the 11-state planning area, while Figures F.16.2-1 through F.16.2-4 show their locations within BLM-administered lands. Table F.3.2-3 (Appendix F, Section F.3.2) lists ACECs designated for protection of cultural resource values, while Table F.12.2-2 (Appendix F, Section F.12.2) lists ACECs designated for protection of paleontological resource values.

4.16.2.2 National Scenic Byways and BLM Back Country Byways

The National Scenic Byways Program, consisting of National Scenic Byways and All-American Roads, was established by the U.S. Department of Transportation's Federal Highway Administration (FHWA). A National Scenic Byway must meet at least one of six criteria that are considered unique, irreplaceable, or distinctly characteristic of an area: scenic, historic, recreational, cultural, archaeological, and/or natural qualities. For a Byway to be designated as an All-American Road, it must meet at least two intrinsic qualities that are nationally significant and have one-of-a-kind features that do not exist elsewhere. The road or highway must also be considered a "destination unto itself." That is, the road must provide an exceptional traveling experience so recognized by travelers that they would make a drive along the highway a primary reason for their trip (FHWA 2021).

The BLM's Back Country Byways are a component of the National Scenic Byways Program. BLM can nominate National Scenic Byways, but the nominations must be submitted and approved by state governments before they are eligible for consideration by the Secretary of Transportation. BLM Back Country and Scenic Byway designations are approved by the state director within the parameters established for the state byway program. BLM Handbook 8357-1 (BLM 1993) presents guidance and other information on BLM's Byway program. The primary focus of the BLM Byway program is the designation and management of Back Country Byways. The components of BLM's byway program include (1) national scenic and BLM scenic byways, which focuses on scenic corridors along major secondary and primary highways; and (2) BLM back country byways, which focuses primarily on corridors along back country roads which have high scenic, historic, archaeologic, or other public interest values.

Back country byways may vary from a bike trail to a low-speed, paved road that traverses back country areas. In general, *byway* refers not only to the road or highway itself, but also to the corridor through which it passes (BLM 2015b). BLM (undated i) provides general information on byways.

4.16.3 Land with Wilderness Characteristics (LWC)

A LWC is not a special designation or land use allocation but rather a determination of areas that have been inventoried and identified as possessing wilderness characteristics. LWCs are not part of the NCL. BLM Manual 6310 (BLM 2021e) provides policy and guidance for conducting wilderness characteristics inventories under Section 201 of FLPMA, while BLM Manual 6320 (BLM 2021f) provides policy and guidance for considering wilderness characteristics in land use plans and land use plan amendments or revisions under Section 202 of FLPMA. BLM Manual 6310 also directs district and field managers to review and document relevant data, including information from state and local governments and citizen-submitted information, for conducting and maintaining the wilderness characteristics inventory on a continuing basis (BLM 2021e).

Through inventories the BLM determines whether lands under its jurisdiction possess wilderness characteristics, which are: roadless size, naturalness, and outstanding opportunities for solitude or primitive and unconfined recreation. Specifically, it determines whether areas meet the following criteria:

- Size:
    - Roadless area with over 5000 acres of contiguous BLM-administered lands; or
    - Roadless areas less than 5000 acres of contiguous BLM-administered lands where any of the following apply:

        - They are contiguous with lands formally determined to have wilderness or potential wilderness values or any federally administered lands managed for the protection of wilderness characteristics such as designated wilderness areas, WSAs, USFWS areas proposed for wilderness designation, USFS WSAs or areas recommended of recommended wilderness, and NPS areas recommended or proposed for wilderness designation.
        - It is demonstrated that the area is of sufficient size to make practicable its preservation and use in an unimpaired condition.
        - Any roadless island of public lands.
- Naturalness: The degree to which an area generally appears to have been affected primarily by the forces of nature with the imprint of people’s work substantially unnoticeable.
- And outstanding opportunities for either:
    - Solitude: When the sights, sounds, and evidence of other people are rare or infrequent and where visitors can be isolated, alone, or secluded from others; or
    - Primitive and unconfined recreation: Non-motorized, non-mechanized (except as provided by law), and undeveloped types of recreational activities.

When the BLM has inventoried an area and determined that it possesses wilderness characteristics, it is not required to protect those characteristics as a priority over other resource values and multiple uses. The BLM has full discretion in how to manage an area that possesses wilderness characteristics and may decide whether or not to protect such characteristics and by what specific management prescriptions through a subsequent land use planning decision (BLM 2021f).

Table F.16.2-9 (Appendix F, Section F.16.2) summarizes the LWCs within the 11-state planning area, while Figures F.16.2-1 through F.16.2-4 show their locations within BLM-administered lands.

4.17 Transportation

Multiple regional and local roadways and railroads occur in the 11-state region, totaling thousands of miles of both roads and railroads. Table 4.17-1 presents highway statistics for rural areas in these states. This data does not include the gravel access roads within BLM-administered lands. The interstates provide the highest level of mobility and highest speeds. Other freeways and arterial roads supplement the interstate system that connect principal urbanized areas, cities, and industrial centers. Collectors are major and minor roads that connect local roads and streets with arterials, whereas local roads provide limited mobility and are the primary access to residential areas, businesses, farms, and other local areas (FHA 2000). One or more of these functional road classes may serve as worker access routes to solar energy facilities and could be intersected and/or parallel associated transmission lines. Local roads paved two-lane roads, and/or possibly, gravel roads would most likely serve, or be developed to serve, future solar energy facilities, and would be most likely affected by construction traffic or impacted by heavy equipment. The majority of the onsite roads are expected to be one-lane dirt or gravel roads that provide access to the solar field and associated transmission lines.

Table 4.17-1. Miles of Public Road Length in Rural Areas by Functional System[a]

State	Interstate	Other Freeways and Expressways	Other Principal Arterial	Minor Arterial	Major Collector	Minor Collector	Local	Total
Arizona	916	19	1,263	2,186	3,336	2,970	32,470	**43,160**
California	1,208	408	3,396	6,271	12,489	7,685	43,484	**74,942**
Colorado	648	28	2,569	3,474	5,457	8,824	47,275	**68,274**
Idaho	521	40	1,716	1,466	5,923	3,699	32,031	**45,395**
Montana	1,095	-	2,773	2,848	6,882	8,821	46,833	**69,252**
Nevada	57	-	1,519	726	2,259	2,406	29,348	**36,715**
New Mexico	844	-	1,916	2,277	4,515	3,132	48,223	**60,907**
Oregon	95	-	2,657	2,225	8,172	7,944	42,798	**64,291**
Utah	685	12	1,191	1,293	3,243	3,477	26,372	**36,272**
Washington	429	612	1,313	2,068	8,090	6,225	36,063	**54,800**
Wyoming	807	-	1,969	1,220	2,718	8,657	11,816	**27,187**
Total	**7,305**	**1,119**	**23,282**	**26,054**	**13,526**	**63,840**	**396,713**	**531,839**

[a] To convert to km, multiply by 1.61.
Source: FHA (2023).

There are also thousands of miles of railroads in the 11-state planning area (Table 4.17-2). Transmission lines associated with solar energy facilities could parallel and, in some cases, cross over railroads.

Table 4.17-2. Miles of Freight Railroads[a, b]

State	Miles	State	Miles	State	Miles	State	Miles
Arizona	1,724	ID	1,654	NM	1,859	WA	2,867
California	4,948	MT	3,680	OR	2,369	WY	1,860
Colorado	2,545	NV	1,193	UT	1,388	**Total:**	**26,087**

[a] To convert to km, multiply by 1.61.
[b] Passenger trains mostly run on the same tracks.
Source: Bureau of Transportation Statistics (2021).

4.18 Tribal Interests

Federally recognized Tribes are sovereign nations within the borders of the United States with the inherent right to govern themselves and are recognized as such under the U.S. Constitution, treaties, statutes, E.O.s, and court decisions. The United States government has federal trust responsibility and legal obligation to Indian Tribes due to nearly two centuries of treaty making; it has been the “supreme law of the land” that such treaties must be upheld. Such treaties have enabled federally recognized Tribes to exercise their unique rights to hunt, fish, and gather foods, medicine, water, and mineral resources; and allowed rights to conduct spiritual and religious practices in traditional places. These treaty rights shall continue to be upheld.

Under E.O. 13175 and 86 FR 7491, federal agencies have an obligation to conduct formal Government-to-Government consultation with federally recognized Tribes. Other federal laws and DOI guidance that requires BLM to consult on any actions on federally administered lands that may have the potential to affect Tribal cultural and natural resources of importance include, but are not limited to Section 106 of the NHPA; the American Indian Religious Freedom Act of 1978; the Native American Graves Protection and Repatriation Act of 1990; E.O. 13007, "Indian Sacred Sites"; BLM H-1601-1 Land Use Planning Handbook (BLM 2005a); DOI Secretarial Order 3215; DOI Department Manual, Chapter 2 *Principles for Managing Indian Trust Assets* (DOI 2000); BLM Manual 1780, *Tribal Relations* (BLM 2016k); BLM Handbook H-1780-1, *Improving and Sustaining BLM–Tribal Relations* (BLM 2016l); and PIM 2022-011, "Co-Stewardship with Federally Recognized Indian and Alaska Native Tribes Pursuant to Secretary's Order 3403" (BLM 2022h).

This section identifies federally recognized Tribes and potential items of interest to those Tribes within the 11-state planning area that may be affected by utility-scale solar energy development.

Tribal ancestral lands are considered any territories that were historically inhabited, used, or traversed through by Tribes. Lands of Tribal significance may no longer be inhabited by Tribes but may also contain properties of traditional, religious, and cultural importance, and are to be managed by federal agencies in consultation with Tribes according to 36 CFR 800.16(1)(1). Figure F3.2-1 illustrates potential Tribal cultural areas of significance and affiliation; however, Tribally affiliated territories shall only be properly defined by Tribes and any figures in this document depicting traditional Tribal territories require review by Tribes through formal consultation.

Other lands that have the potential to be impacted by federal actions are Indian Trust Lands, Indian Reservations, restricted status lands, and Tribally owned private property (Table 4.18-1; Figure 4.18-1). The BLM has identified 240 federally recognized Tribes that may consider some BLM-administered lands as areas of ancestral significance to Tribes in the 11-state planning area. Appendix D includes a list of Tribes that have been contacted by BLM because they have cultural affiliation with lands within solar-suitable areas (USFS 2023b; USCB 2023). Due to a history of removal and displacement of Tribes within the United States since the early 1800s, it is difficult to identify all Tribes that may have affiliation to BLM-administered lands. Any additional Tribes not mentioned in this document require identification through continuous formal outreach and consultation.

Table 4.18-1. Federal Indian Lands[a]

State	Indian Reservations	Indian Trust Lands (acres)	Indian Trust Lands within BLM Territory (acres)
Arizona	21	16,226	21
California	106	35,884	0
Colorado	2	0	0
Idaho	5	3,602	0
Montana	7	166,073	363
Nevada	27	101,021	4,580
New Mexico	26	1,420,365	19,830
Oregon	10	40,625	153
Utah	7	8,276	0
Washington	29	33,226	242
Wyoming	2	5,051	0

[a] Note: Some Indian Reservations and Indian Trust Lands may be counted twice when crossing state borders. Some Tribes may also be affiliated with more than one state area.

Tribal people have a deep understanding of the land and possess unique historic knowledge passed down through generations that uniquely enables them to identify resources and properties of cultural, spiritual, and historic significance. Tribes often request that natural and cultural resources be managed together because of their holistic view of their environment. Any damage to one part of the landscape may damage the whole, and "distinctions between the natural and the cultural and the animate and the inanimate as viewed by western societies may have little meaning from a traditional Tribal perspective" (Stoffle and Zedeño 2001; BLM 2010).

Due to the holistic perspective Tribes carry, their interests often extend beyond protecting cultural resources but may also have concerns encompassing all of the following: trust assets and resources, TCPs, burial remains, sacred sites or landscapes, ecological balance and environmental protection, water quality and use, human health and safety, economic development and employment, rights to hunting, fishing, and gathering of specific resources for traditional purposes and use, access to livestock grazing, and access to energy resources (BLM 2010). The federal government is required to engage in Government-to-Government consultations when proposing actions that could affect resources of Tribal significance. Potential effects to these resources are discussed in the following sections and shall be evaluated collectively and concurrently with Tribes through formal consultation: Cultural Resources, Geological Setting and Soil Resources, Mineral Resources, Water Resources, Air Quality and Climate Resources, Visual Resources, Acoustic Environment, Rangeland Resources including Livestock Resources, and Ecological Resources. Some resources have distinct management requirements based on federal legislation, E.O.s, and court decisions (Table 4.18-2; BLM 2010). Any other resources later identified by Tribes through consultation will be included.

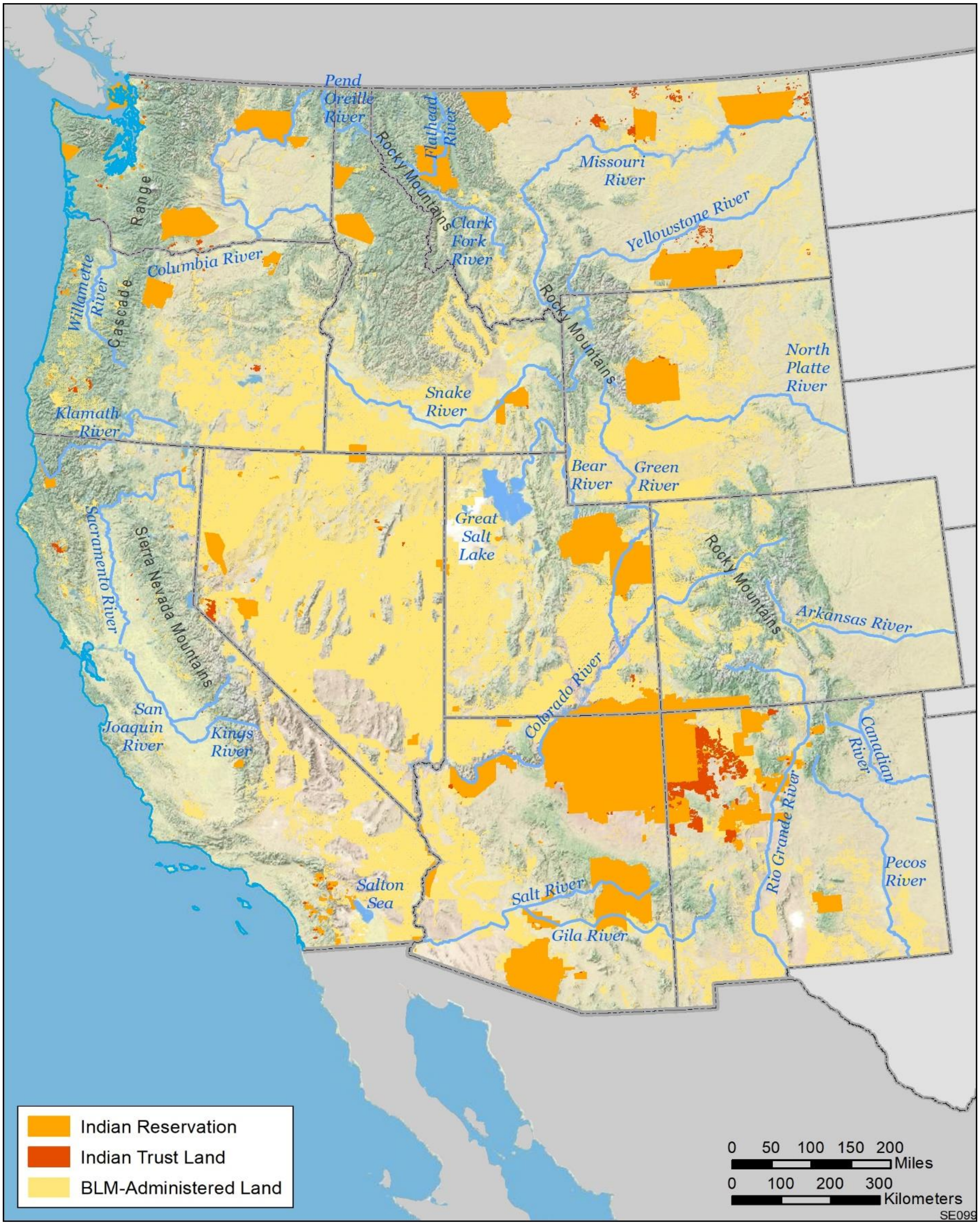


Figure 4.18-1. Current Tribal Land Holdings

*Note: this map does not depict all ancestral lands that may be considered as lands available for future solar energy development.

Table 4.18-2. Special Considerations for Tribal Consultation

Resource Type	Description
Archaeological sites	The physical remains of human activities, including artifacts, structures, and special use sites. All prehistoric and some historic archaeological sites in the United States are associated with ancestral Native American populations. These sites often include a buried (subsurface) component.
Indian trust assets (ITAs)	ITAs are legal interests in property held in trust by the United States for Indian Tribes or individuals. Interior's policy is to recognize and fulfill its legal obligations to identify, protect, and conserve the trust resources of federally recognized Indian Tribes and individual Indians, to the extent required by relevant statutes and regulations; and to consult with Tribes on a Government-to-Government basis whenever plans or actions affect Tribal trust resources, trust assets, or Tribal health and safety (DOI 2012).
Indian trust resources	Those natural resources, either on or off Indian lands, retained by or reserved by or for Indian Tribes through treaties, statutes, judicial decisions, and E.O.s, which are protected by a fiduciary obligation on the part of the United States (DOI 2008).
Native American Graves Protection and Repatriation Act remains	Native American human remains, funerary objects, sacred objects, or objects of cultural patrimony found on federal lands or residing in museums receiving federal funding.
Properties of traditional religious and cultural importance to an Indian Tribe	Often referred to as TCPs, these features may be eligible for listing on the *NRHP*. They include sacred sites, burial grounds, ancestral sites, traditional gathering places, and culturally important landscapes and natural resources (36 CFR 800.16(l)(1)).
Sacred sites	Any specific location on federal land that is identified by an Indian Tribe or Indian individual determined to be an appropriately authoritative representative of an Indian religion, as sacred by virtue of its established religious significance to, or ceremonial use by, an Indian religion (GSA 1999).
Tribal lands	All lands within the exterior boundaries of an Indian reservation and all dependent Indian communities (36 CFR 800.16(x)).
Treaty rights	Rights reserved to Native Americans by treaties, including hunting, fishing, gathering, and mineral rights.
TCPs	Properties eligible for inclusion in the *NRHP* based on its association with the cultural practices, traditions, beliefs, lifeways, arts, crafts, or social institutions of a living community. TCPs are rooted in the community's history and are important in maintaining the continuing cultural identity of the community.

Source: (BLM 2010).

A list of resources designated for protection (e.g., ACECs) can be found in Appendix F, Section F.3.2.2; and topics of additional concern previously identified through prior consultation efforts are in Appendix K of the 2012 Western Solar Plan Final EIS (BLM and DOE 2012). Tribal resources of concern within the 11-state planning area will to be identified and shall be determined through formal Government-to-Government consultation. Failure to consult can result in adverse relationships with sovereign nations, unlawful treatment, damage, or loss of unique resources and substantial delays in project development.

4.19 Visual Resources

The BLM's visual resource inventory (VRI) represents the scenic (visual) values distribution for a land use planning area. The VRI is the product of a scenic resource inventory process that includes assessment of three factors: scenic quality of the landscape (e.g., what the landscape looks like), visual sensitivity (e.g., public concern for scenic quality in the landscape), and distance zones (e.g., locations from where the public views the landscape). In the inventory process, the scenic quality value is determined by considering seven key factors: landform, vegetation, water, color, adjacent scenery, scarcity, and cultural modifications. During the inventory process, each factor is ranked on a comparative basis with similar features within the region (i.e., the physiographic province as delineated by Fenneman [1946]). The boundaries of these provinces may be refined to fit local situations, based on ecoregions (see Section 4.19.1).

The VRI does not direct management but provides the basis (i.e., the existing conditions) for making decisions on the management of visual values in the land use planning process. Through the land planning process, the BLM identifies visual resources management (VRM) classes (allocations) for every acre of BLM-administered lands within the land use plan decision area. The VRM class objectives set the threshold for allowable visual change and describe the desired future condition of the landscape to which proposed projects or activities on BLM-administered lands must conform. The VRM classes may differ from the VRI classes because they reflect other resource concerns and land uses considered during the land use planning process. For example, a VRI Class II could be managed as a VRM Class IV due to other desired resources uses, or a VRI class IV could be managed as a VRM Class II due to public preferences or other resource concerns.

Because the VRI represents the scenic values for a planning area, it is used for describing the impacts on visual resources when implementing the land use plan or authorizing projects or activities on BLM-administered lands. The scenic quality factor of the VRI is the direct measure of the quality and quantity of the scenic resource, and so in this Programmatic EIS serves as the primary basis for analysis and discussion of visual impacts. Table 4.19-1 shows acreages and percentages by state for each VRI scenic quality rating class on BLM-administered land. Scenic quality is rated as A, B, or C where an “A” rating reflects the highest scenic quality, a “B” rating reflects an intermediate-level scenic quality, and a “C” rating reflects the lowest scenic quality. An 11-state map of BLM-inventoried scenic quality ratings is shown in Figure 4.19-1. Individual state maps of scenic quality are available in Appendix F, Section F.19.2.

4.19.1 Visual Resources in the 11-State Planning Area

The 11 states analyzed in this Programmatic EIS encompass a great variety of landscape types, determined by geology, topography, climate, soil type, hydrology, and land use. This vast region, which encompasses nearly 1,187,000 mi^2 (3.1 million km^2), includes spectacular landscapes such as the Grand Canyon and Glacier, Yosemite, and Zion national parks as well as relatively flat and visually monotonous landscapes such as the High Plains of eastern Colorado. Although much of the region is sparsely populated, human influences have altered much of the visual landscape, especially with respect to land use and land cover. In some places, intensive human activities, such as mineral extraction and energy development, have degraded scenic (visual) values. Population growth and expansion of urban areas such as Las Vegas and Phoenix continue to put development pressure on adjacent relatively intact landscapes.

Table 4.19-1. Scenic Quality Rating Values for BLM-Administered Lands Within the 11-State Planning Area[a]

State	BLM-Administered Land (acres)	Scenic Quality Rating "A"		Scenic Quality Rating "B"		Scenic Quality Rating "C"		Missing, Not Inventoried, or No Data	
		acres	%	acres	%	acres	%	acres	%
Arizona	12,109,387	1,953,967	16	4,148,823	34	2,794,597	23	3,212,001	26
California (excludes DRECP/CDCA)	4,159,560	253,194	6	258,623	6	43,020	1	3,595,509	86
Colorado	8,354,303	772,190	9	2,931,644	35	1,836,222	22	2,814,247	34
Idaho	11,774,830	500,446	4	1,626,552	14	3,807,695	32	5,840,137	50
Montana	8,043,026	208,584	3	1,319,003	16	2,054,410	26	4,461,028	56
Nevada	47,272,247	3,118,701	7	25,873,702	55	16,833,581	36	1,446,810	3
New Mexico	13,493,392	2,101,017	16	4,332,446	32	3,782,169	28	3,277,760	24
Oregon	15,718,196	972,810	6	3,512,179	22	3,078,431	19	8,154,777	52
Utah	22,767,896	4,137,860	18	9,965,847	44	8,104,185	36	560,003	3
Washington	437,237	45,779	11	314,082	72	60,191	14	17,185	4
Wyoming	18,047,492	749,653	4	5,180,725	29	5,955,825	33	6,161,289	34
Total	**162,177,567**	**15,093,173**	**9**	**62,632,997**	**39**	**52,066,942**	**32**	**43,206,237**	**27**

[a] Areas of Scenic Quality Rating Classes do not total to 100% of BLM-administered lands because not all lands have been inventoried, or the inventories are not consistent with BLM data standards and are not included here.

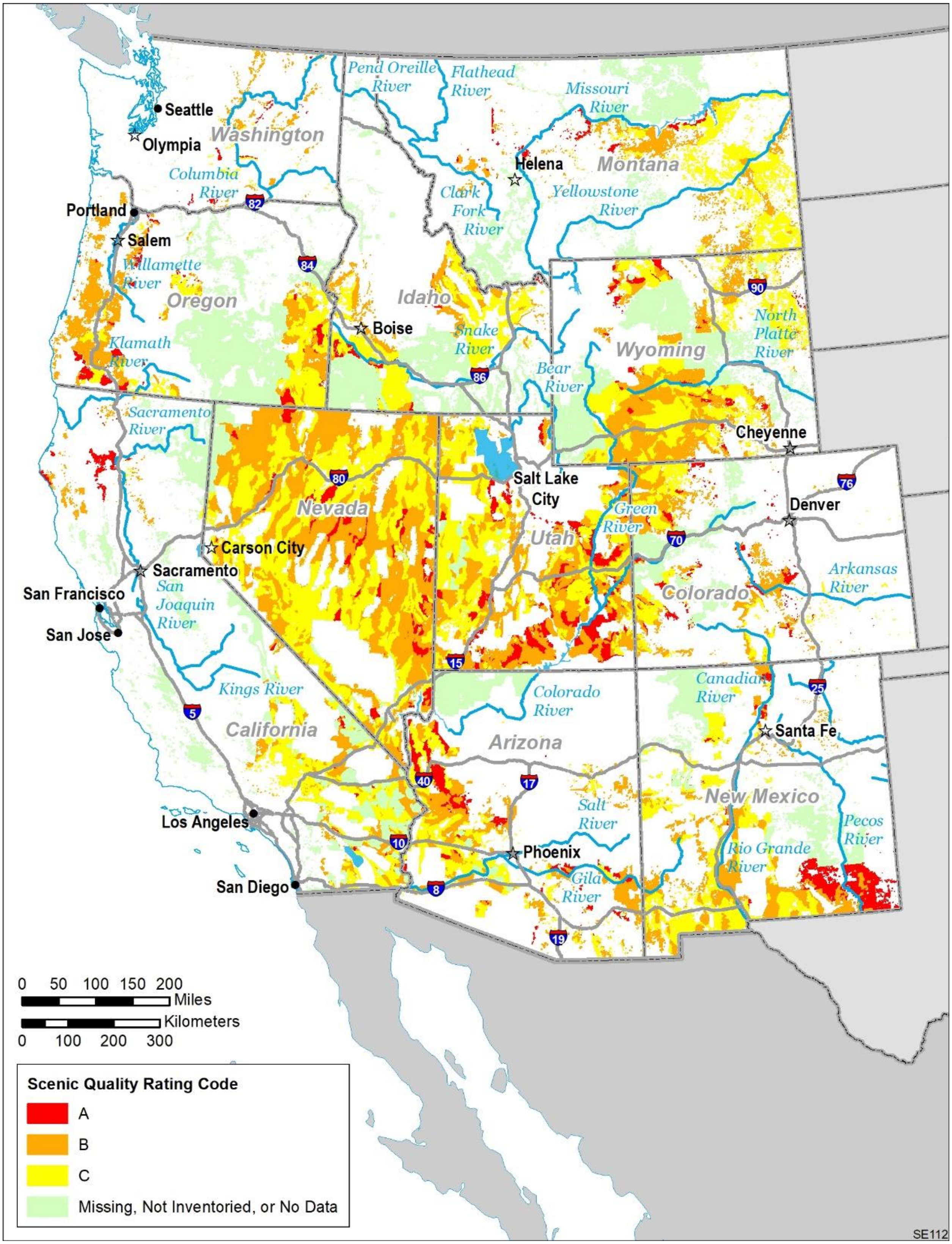


Figure 4.19-1. BLM VRI Scenic Quality Ratings in the 11-State Planning Area (Sources: BLM2023)

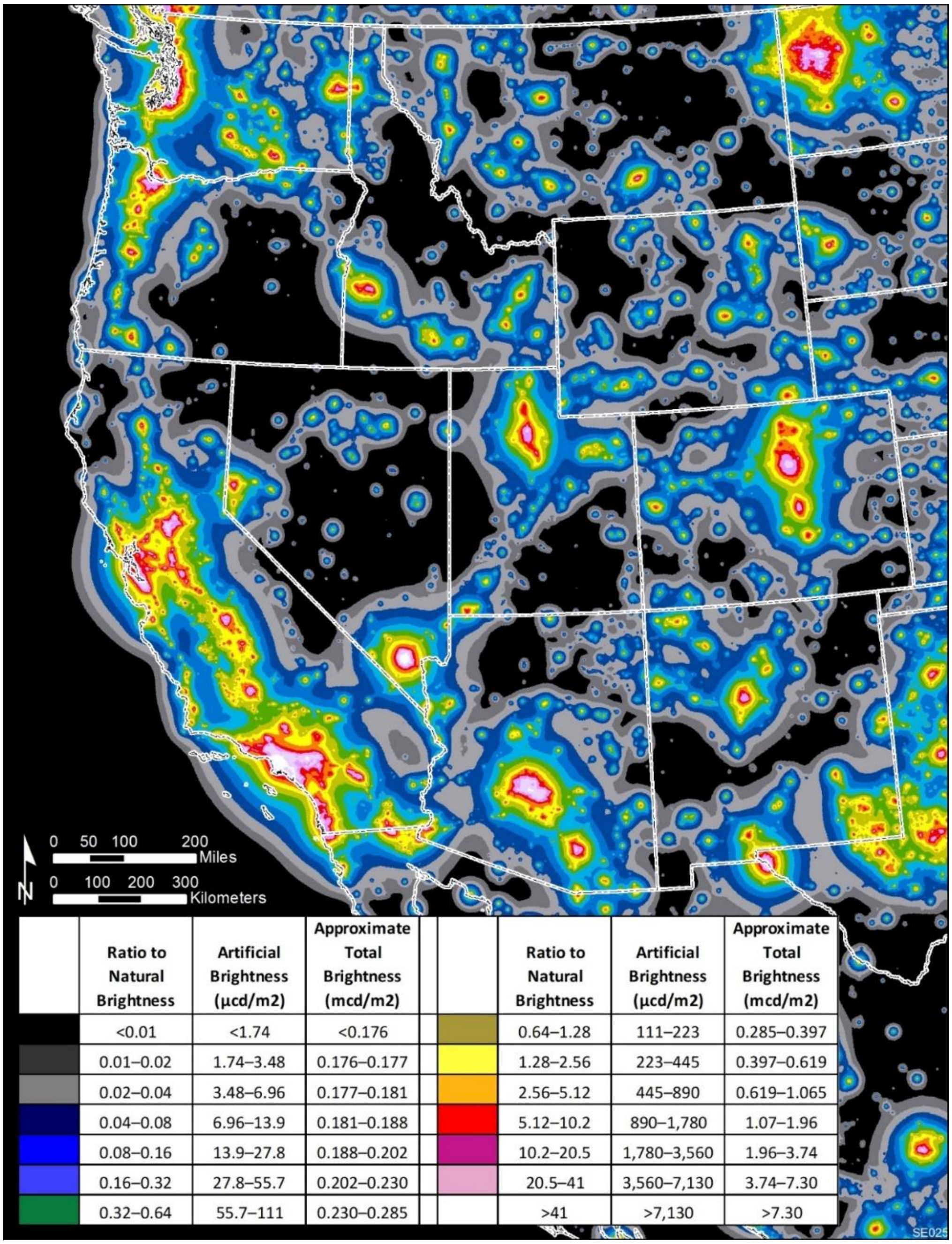
Millions of tourists visit the 11-state region each year because of its scenic quality and variety, and the high level of visitation contributes to making tourism a major component of some regional and local economies. BLM-administered lands also contribute to the scenic variety and visitor attraction to the planning area. Areas within BLM where scenery is an important component of visitor experience include BLM NCLs (Section 4.16) and recreation management areas (Section 4.12). Other areas managed by BLM for scenery include ACECs, if scenic values were identified as relevant and important values where special management attention is needed (Section 4.16).

While solar energy development assessed in this Programmatic EIS generally would be precluded from these sensitive visual resource areas (SVRAs) on BLM-administered lands, visual impacts on these areas could occur from solar energy development in nearby areas. In addition, because large-scale solar energy projects may be visible in some circumstances at long distances, SVRAs outside BLM-administered lands could also be subject to impacts from solar energy development on nearby BLM-administered lands. These SVRAs could include national parks, monuments, trails, scenic highways, WSRs, wildlife refuges, and other designated scenic, historic, and cultural resource areas. SVRAs are shown in individual state maps of scenic quality ratings on BLM-administered lands available in Appendix F, Section F.19.2.

Because scenic resources in a given area are largely determined by geology, topography, climate, soil type, and vegetation, such resources are generally homogenous within an ecoregion—an area that has a general similarity in ecosystems and is characterized by the spatial pattern and composition of biotic and abiotic features, including vegetation, wildlife, geology, physiography, climate, soils, land use, and hydrology (EPA 2023i). The ecoregions of the United States as mapped and described by the EPA are used here as the basis for describing visual resources at a general level (see Section 4.1.1, Figure 4.4.1-1). The Level III ecoregion classification includes 35 ecoregions covering the 11-state planning area. The ecoregion descriptions presented in Appendix E were primarily derived from EPA (2013), except where noted.

4.19.2 Night Sky and Natural Darkness Resources in the 11-State Planning Area

The 11-state planning area has night sky and natural darkness resources that are valued by humans and that are ecologically important. An 11-state map of artificial night sky brightness is presented in Figure 4.19-2. Individual state maps of artificial night sky brightness are available in Appendix F, Section F.19.2. These maps were derived from the New World Atlas of Artificial Sky Brightness (Cinzano et al. 2001).



Ratio to Natural Brightness	Artificial Brightness (µcd/m2)	Approximate Total Brightness (mcd/m2)	Ratio to Natural Brightness	Artificial Brightness (µcd/m2)	Approximate Total Brightness (mcd/m2)
<0.01	<1.74	<0.176	0.64–1.28	111–223	0.285–0.397
0.01–0.02	1.74–3.48	0.176–0.177	1.28–2.56	223–445	0.397–0.619
0.02–0.04	3.48–6.96	0.177–0.181	2.56–5.12	445–890	0.619–1.065
0.04–0.08	6.96–13.9	0.181–0.188	5.12–10.2	890–1,780	1.07–1.96
0.08–0.16	13.9–27.8	0.188–0.202	10.2–20.5	1,780–3,560	1.96–3.74
0.16–0.32	27.8–55.7	0.202–0.230	20.5–41	3,560–7,130	3.74–7.30
0.32–0.64	55.7–111	0.230–0.285	>41	>7,130	>7.30

Figure 4.19-2. Artificial Night Sky Brightness in the 11-State Planning Area[19] (Sources: Cinzano et al. 2001)

[19] The second column in the table gives the ratio between observed artificial brightness and the natural background sky brightness (assumed to be 174 µcd/m^2). For example, areas shown in red on the map have night sky brightness values approximately 5–10 times brighter than completely unlit natural areas. The third column gives the brightness contributed by artificial light sources (µcd/m^2); the fourth column gives the approximate total brightness (mcd/m^2). Units of brightness are microcandellas per square meter, and millicandellas per square meter. The candela is a measure of visual intensity of light sources as perceived by humans.

While artificial light at night (ALAN) in densely populated areas in the western states has contributed to substantial levels of light pollution in these areas (Figure 4.16-1), large areas in the western United States have very low levels of light pollution (areas shown in black or gray). The general lack of humans and infrastructure on BLM-administered lands has largely preserved natural darkness and night sky quality.

Dark night skies are an important aesthetic, recreational, cultural, and spiritual resource. Many dark sky areas in the 11-state region are visited for dark sky tourism (also called astrotourism), which is important to the economies of certain communities within these areas. In addition to star parties, many other nighttime recreation activities take place on public lands, including night sky interpretive programs; astrophotography; nighttime wildlife viewing (e.g., owling); and festivals and special events (Smith and Hallo 2012). Many of these experiences depend on, or at least are enhanced by, high-quality night skies and natural darkness.

High-quality night skies are also valued by some Tribal and other cultures where the seasonal appearance of certain constellations or other celestial bodies mark important events such as planting/harvesting; where they may be tied to creation stories or other folklore; or where they provide other individual or communal spiritual value. Knowledge of the night sky is important to many aspects of various cultures including storytelling, symbolism, art, and religious practices. High-quality night skies are also greatly valued by professional astronomers whose work at observatories may be hindered or prevented by even moderate light pollution.

BLM-administered lands are an important resource for nighttime recreational and educational activities, and several BLM visitor areas, such as Grand Staircase-Escalante and Canyons of the Ancients National Monuments, and Red Rock Canyon National Conservation Area have very popular staff-led night sky programs (BLM 2022k). Night sky resources on BLM-Administered lands provide opportunities for esthetic, spiritual, and wilderness experiences, and religious and cultural experiences for Native Americans and others.

The DarkSky International Dark Sky Places (IDSPs) Program encourages communities, parks, and protected areas around the world to voluntarily preserve and protect dark sites through accreditation as one of several types of IDSPs. The BLM-administered Massacre Rim Wilderness has been recognized by Dark Sky as an International Dark Sky Sanctuary (IDA 2019). Grand Canyon-Parashant National Monument (jointly administered by the BLM and NPS) has been recognized by the Dark Sky as the Parashant International Night Sky Province-Window to the Cosmos (IDA 2014). Other BLM-administered areas are currently applying for Dark Sky accreditation. The Dark Sky accreditation does not carry any legal authority. However, it does demonstrate a commitment to protect night skies using responsible outdoor lighting and education; and can raise a community's profile as a destination for dark sky tourism.

BLM does not have a policy for inventorying night sky quality or directing the management of night sky quality associated with BLM-administered lands. However, BLM requires the use of responsible outdoor lighting BMPs as design features for proposed projects or activities on BLM-administered lands to reduce BLM's contribution to light pollution (Sullivan et al. 2023).

4.20 Water Resources

4.20.1 Surface Water Resources

4.20.1.1 Hydrologic Regions

Ten major hydrologic regions are within the 11-state planning area (Figure 4.20-1): (1) Pacific Northwest, (2) California, (3) Upper Colorado, (4) Lower Colorado, (5) Rio Grande, (6) Missouri, (7) Great Basin, (8) Arkansas–White-Red, (9) Souris-Red-Rainy, and (10) Texas–Gulf. Each hydrologic region encompasses either the drainage area of a major river or the combined drainage areas of a series of rivers (USGS 2008). Because of the geographical diversity, the 11-state planning area has considerable climatic variability. Stream discharge in the 11-state planning area is affected by precipitation (which varies with season) and the regional topography. The quality of surface water varies by stream segment and is related to the volume of streamflow, the nature of local bedrock and soils, and human activities (e.g., mining, wastewater discharges, and agriculture). More details of the hydrologic regions, their major river systems, and climate is provided in Appendix F, Section F.20.

4.20.1.2 Floodplains, Ephemeral Streams, and Wetlands

Surface water resources of the affected environment include lakes and rivers as well as numerous floodplains, ephemeral streams (i.e., streams that carry water only briefly in direct response to precipitation), and wetlands. The Clean Water Act (CWA; 33 U.S.C. Parts 1251–1387) is the primary law protecting water quality in surface waters by means of regulatory and nonregulatory methods to limit pollution discharges by point and non-point sources. Additional protections to floodplains, ephemeral streams, and wetlands are provided by E.O. 11988 and E.O. 11990 (42 FR 26951 and 42 FR 26961). Appendix H provides further information on laws and regulations governing surface waters at the state and local levels for the 11-state planning area.

Floodplain maps are usually prepared for populated areas that could experience flooding. These maps are generally prepared by the Federal Emergency Management Agency (FEMA) for floods that statistically have a 1% and 0.2% chance of occurring each year (i.e., 100 and 500-year flood events; FEMA 2023). Stream channels for ephemeral and intermittent streams are often incorporated in the National Hydrography Dataset from the USGS, but drainages and washes often are not. The 11-state planning area contains many mountain valley regions with low-relief alluvial fans. Wetlands in the 11-state planning area are often associated with perennial water sources such as springs, streams, lakes, or ponds.

Figure 4.20-1. Hydrologic Regions in the 11-State Planning Area (Source: USGS 2008)

Surface and groundwaters are integral to supporting riparian, wetland, and aquatic habitat in the 11-state planning area. BLM's Aquatic Resources Program focuses on conserving and restoring riparian, fisheries, and water resources on BLM-administered lands managed by the BLM. Wetlands and aquatic habitat are described in Section 4.4.

4.20.2 Groundwater Resources

Twenty-eight major aquifer systems occur in the 11-state planning area (Figure 4.20-2). Groundwater occurs primarily in unconsolidated and semi-consolidated sand and gravel aquifers, sandstone aquifers, carbonate-rock aquifers, aquifers in interbedded sandstone and carbonate rocks, and igneous (volcanic) and metamorphic rock aquifers.

Shallow groundwater is typically found near the surface in the vicinity of large surface water bodies (i.e., lakes and streams) and near the areas with lowest elevation in a basin. Deeper groundwater may occur at great depths in bedrock aquifers. Recharge of these aquifer systems occurs mainly through precipitation, especially in mountainous areas where snow precipitation is substantial and evaporation is relatively low. Groundwater discharges to local streams and rivers and to springs in valleys of low-lying areas and in alluvial fans. More details of groundwater resources including sole-source aquifers are provided in Appendix F, Section F.20.

4.20.3 Water Rights, Supply, and Use

The arid climate and scarcity of water resources throughout the 11-state planning area make water rights and management of extreme importance in achieving beneficial uses of water resources while maintaining healthy aquatic ecosystems. States have primary authority and responsibility for the allocation and management of water resources within their borders except as otherwise specified by Congress. The BLM cooperates with state governments and complies with applicable state laws to the extent consistent with federal law to acquire, perfect, protect, and manage water rights to protect water uses identified for public land management purposes. The BLM ensures that land use authorizations granted to third parties contain appropriate terms and conditions to protect BLM-administered water rights and uses. Third-party uses of appropriated water on BLM-administered lands that operate under BLM permitting authority shall comply with applicable state laws, federal laws, and E.O.s.

Water rights and management activity varies by state. An important component to any solar energy development plan will be a project-level water availability assessment to determine if water is physically and legally available to meet the necessary water requirements consistent with the BLM's sustained-yield mission. The myriad of applicable laws and agencies regulating water resources in any one location is complex and often needs to be assessed on a case-by-case basis. Varying water management doctrines and approaches exist among the states, and sometimes surface water resources are managed differently than groundwater resources.

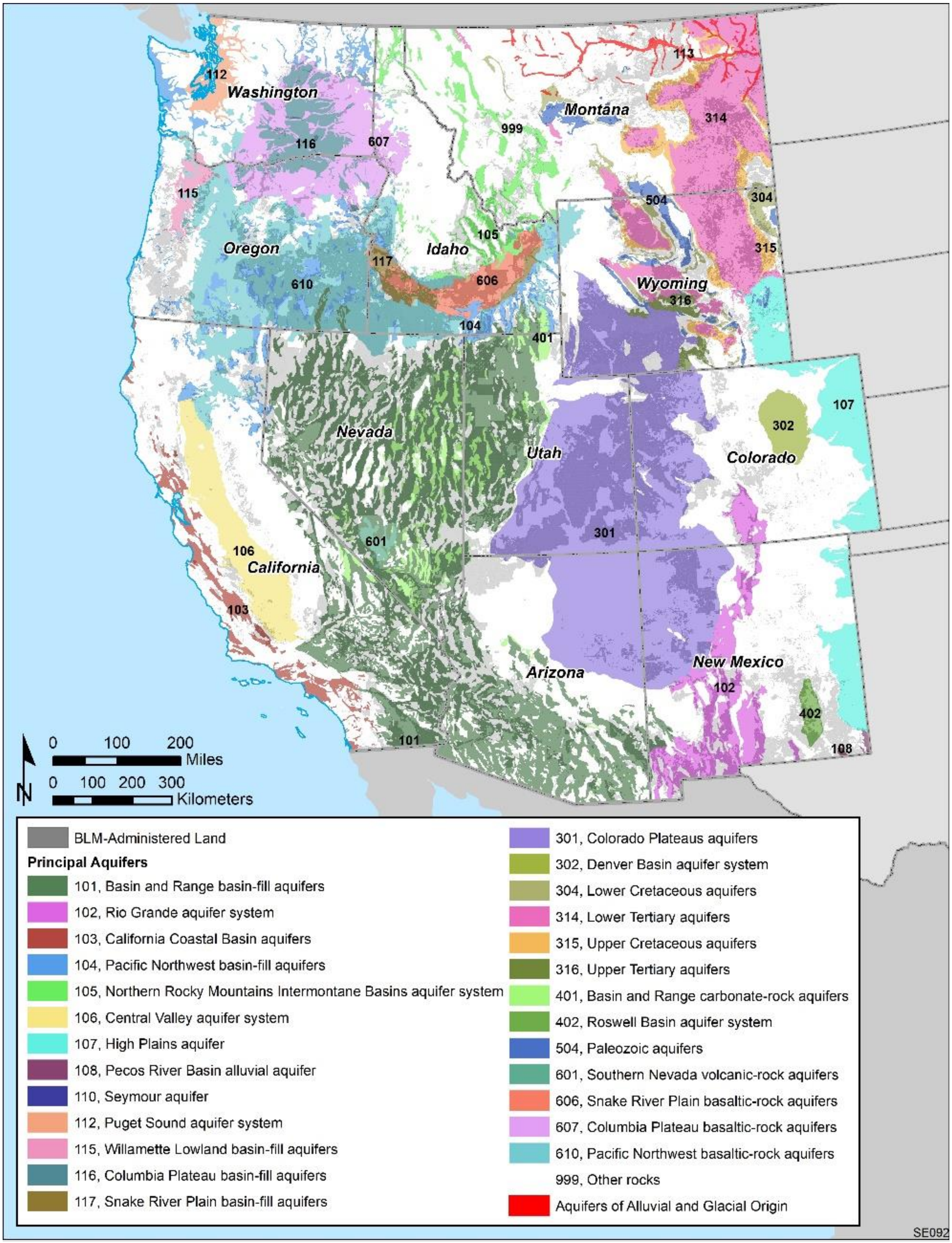


Figure 4.20-2. Major Aquifer Systems in the 11-State Planning Area (USGS 2023b)

Water resources planning in various states considers long-term trends to assure balance between water demand and availability. Drought conditions, which have occurred in the region since early 2000, may reduce the water supply substantially from time to time, thus affecting the pattern of water use. While the 2000-2021 period was driest in several centuries (Park et al. 2022), in May 2023, following a wet winter, the total area of the western United States (the 11-state planning area) under drought is nearly 50% less than at the beginning of October 2022 (NIDIS 2023). Wet years are not uncommon within multidecadal droughts.

Water use may also be legally restricted because of water right issues and various interstate compacts. As water rights can be transferred or traded, the use of water among various sectors could also change with time. Such transfer of water rights is affected by national and local economies. Regional population growth and weather patterns related to climate change may also contribute to the variation of water supply and use. Finally, conservation measures implemented in different states change water use behaviors. Water supply and use are dynamic and interdependent in nature. More information on water rights, supply, and use are provided in Appendix F, Section F.20.

Several international compacts pertain to the governing of water rights in the 11-state planning area for both surface waters and groundwater. Additional description of these compacts is provided in Appendix F, Section F.20.

Water Use by Categories in the Planning Area. Since 1950, the USGS has reported national water-use data by source and by categories every 5 years (see USGS 2023b). The 2015 report is the most recent report currently available (Dieter et al. 2018). Table 4.20.3-1 lists the 2015 total water use data for the 11-state planning area.

Table 4.20.3-1. Total Water Withdrawals by Source in the 11-State Planning Area[a]

State	Groundwater			Surface Water			Total		
	Fresh	Saline	Total	Fresh	Saline	Total	Fresh	Saline	Total
Arizona	3,092	0	3,092	3,607	0	3,607	6,700	0	6,700
California	19,154	402	19,490	9,566	3,136	12,658	28,700	3,550	32,200
Colorado	1,680	27.1	1,714	9,857	0	9,857	11,500	27.1	11,600
Idaho	5,993	0	5,993	13,890	0	13,890	19,900	0	19,900
Montana	211	18.3	230	10,765	0	10,765	11,000	18.3	11,000
Nevada	1,523	92.2	1,613	1,703	0	1,703	3,230	92.2	3,320
New Mexico	1,512	100	1,613	1,635	0	1,635	3,150	100	3,250
Oregon	1,658	0	1,658	5,713	0	5,713	7,370	0	7,370
Utah	1,176	104	1,288	3,159	288	3,450	4,340	392	4,740
Washington	1,714	0	1,714	3,058	0	3,058	4,770	0	4,770
Wyoming	730	108	838	8,289	0	8,289	9,020	108	9,130

[a] Measured in thousand ac-ft. The component numbers for source and type may not add up to the total reported because of individual rounding.

Source: Dieter et al. (2018).

The USGS also reported state-wise water withdrawals for domestic, irrigation, livestock, aquaculture, industrial, mining, and thermoelectric power water-use categories. Table 4.20.3-2 lists the 2015 water use data by categories for the 11-state planning area. The USGS also provides the breakdown of state-wise water withdrawals for the categories listed above between surface water and groundwater (Dieter et al. 2018).

Table 4.20.3-2. Total Water Withdrawals by Category in the 11-State Planning Area[a]

State	Public Supply, Total	Domestic, Fresh	Irrigation, Fresh	Live-stock, Fresh	Aqua-culture, Total	Industrial		Mining		Thermoelectric Power		Total		
						Fresh	Saline	Fresh	Saline	Fresh	Saline	Fresh	Saline	Total
Arizona	1,340	26.9	5,080	43.6	38.7	6.86	0	76.6	0	93.6	0	6,700	0	6,700
California	5,770	142	21,300	205	815	447	0	51.3	305	40.8	3,180	28,700	3,550	32,200
Colorado	946	39.6	10,100	37.3	292	94.2	0	8.63	27.1	41.7	0	11,500	27.1	11,600
Idaho	309	78.6	17,100	56.9	2,200	64.6	0	25.9	0	2.01	0	19,900	0	19,900
Montana	172	26.6	10,600	47.3	19.2	10.8	0	24.2	18.3	84.8	0	11,000	18.3	11,000
Nevada	596	40.1	2,320	5.54	38.2	6.40	0	219	12.6	9.79	79.5	3,230	92.2	3,320
New Mexico	293	27.6	2,660	35.9	27.0	3.81	0	63.7	100	37.5	0	3,150	100	3,250
Oregon	636	82.8	5,780	18.2	710	117	0	12.7	0	12.7	0	7,370	0	7,370
Utah	702	11.6	3,390	17.8	93.1	60.7	88.5	3.89	289	68.4	9.48	4,340	392	4,740
Washington	971	123	2,830	33.3	275	462	0	19.1	0	58.5	0	4,770	0	4,770
Wyoming	114	10.0	8,730	18.1	32.3	9.01	0	49.8	108	58.1	0	9,020	108	9,130

[a] Measured in thousand ac-ft. The component numbers for source and type may not add up to the total reported because of individual rounding.
Source: Dieter et al. (2018).

Since 2005, there has been a national trend of decreasing total water withdrawals (Dieter et al. 2018). Within the 11-state planning area, the change in 2015 total water use compared to the 2010 total water use ranged from a 73% increase (Wyoming) to a 24% decrease (California). The change in surface water use ranged from 81% increase (Wyoming) to 55% decrease (California). The change in groundwater use ranged from 37% increase (California) to 31% decrease (Oregon). Over the whole 11-state planning area, total water use decreased 5% with an associated 14% decrease in surface water use and an 18% increase in groundwater use. Among water-use categories for the whole 11-state planning area the changes from 2010 to 2015 included minor increases in mining, irrigation, and livestock water use (3%, 2%, and 1%, respectively), and decreases in other categories ranging from an 8% decrease in domestic freshwater use to a 53% decrease in thermoelectric power water use. The decrease in thermoelectric power water use can be attributed to plant closures, increased use of natural gas over coal, and newer, more water-efficient cooling technologies. Water use for public supply has decreased 11% in 2015 compared to 2010 in the 11-state planning area.

4.21 Wildland Fire

The 11 states in the Programmatic EIS planning area have a wide range of climates and fuel types, and wildland fire is a factor to be considered as part of the site-specific planning for solar energy facilities. The causes of fires can be either lightning (natural) or man-made. Fire management and protection may be provided by BLM or cooperating organizations, such as private, state, or other federal agency fire organizations.

Despite the cause (natural or man-made) wildland fire is projected to undergo changes by the middle and end of the century. Understanding wildland fire indicators in each state as well as their projected changes, therefore, is important for programmatic planning of solar energy facilities. In this Programmatic EIS, wildfire risk is evaluated here in terms of historical trends in fire location and size and by evaluating projected changes using dynamically downscaled ensembles of three global climate models.

The Fire Program Analysis (FPA) Fire-Occurrence Database (FOD; Short 2014) from the U.S. Department of Agriculture (USDA) provides a comprehensive record of federal, state, and local wildland fire records from 1992–2020, identifying the location, cause of fire, discovery date, and final fire size. Table 4.21-1 shows recorded change in wildland fire characteristics between the first 14 years (1992–2005) and last 14 years (2006–2020) for each state. Colorado and Wyoming have the largest increases in total number of fires (127% and 47%, respectively), while Nevada, Utah, Oregon, Idaho, and New Mexico have all seen decreases. Despite some states experiencing a decrease in total number of fires, all states have seen an increase in fire size. Rather than look at just the change over the two periods, it is pertinent to understand the cumulative impacts of wildfires over the past 20 years in these areas. Since this dataset only goes until 2020, we use the past 20 years of fire data (2003–2022), provided by the Wildland Fire Interagency Geospatial Services Group to provide more updated results. Table F.21.2-1 provides an analysis of the number of acres that have been burned based on the number of times that they burned over the last 20 years. This provides a look at the state level to understand which states have the most land affected when wildfires occur and which states have the most land on which multiple wildfires have occurred. In total, over 10 million acres of land have been burned by at least one fire over the past 20 years, with lands in California, Idaho, Nevada, and Oregon being the most susceptible.

There are many potential causes of wildland fires, a summary of which is given in Figure 4.21-1 (Short 2014). Naturally caused wildfires (due to lightning) are the most reported wildfire cause in states where strong convective storms are likely (Colorado, Utah, Wyoming, Montana, and Nevada). Human-caused fires are the most ubiquitous and most reported wildfire cause across all states, mainly induced through debris and open burning, recreation and ceremony, and equipment and vehicle use. There are also many wildfires for which the cause cannot be determined, so when planning in wildland fire prone zones, more mitigation strategies will need to be adopted to cover a wider range of possible fire causes.

Table 4.21-1 displays changes in the number of fires and fire size from the USDA Fire Program Analysis Fire-Occurrence Database dataset (Short 2014), comparing changes during the periods of 2006–2020 and 1992–2005. The percent changes in the European Forest Fire Information System (EFFIS) classification categories (San Miguel Ayanz et al. 2003) are based on dynamically downscaled model data between the historical (1995–2004) and mid-century (2045–2054) model periods. They represent predicted changes in the relative risk of a wildland fire occurring. This table summarizes Appendix F, Tables F.21.2-1a and F.21.-2-1b.

The Canadian Forest Fire Weather Index (CFWI) is a measure of six variables (both meteorological and physical) that convey the general fire intensity potential in an area based on fuel availability and meteorological factors (Wagner 1974, 1987). Recent research has produced dynamically downscaled projections of future climate scenarios using available climate model data (Wang and Kotamarthi 2015; Zobel et al. 2017, 2018). Trends in CFWI across the 11 states from the historical (1995–2004) to projected mid-century (2045–2054) periods are shown in Figure 4.21-2. Most states are expected to experience average increases between 10-20% in average annual CFWI, suggesting an increase in areas susceptible to wildland fires. Certain areas in the region such as Eastern Montana, Eastern Wyoming, and Eastern Colorado are projected to see decreases between 5-15%. To further understand the potential risks of this increase, Figure 4.21-3 shows the spatial distribution of USDA-estimated Burn Probability representing the probability of a given area to burn under 2014 landscape conditions and fire management practices (Short et al. 2020).

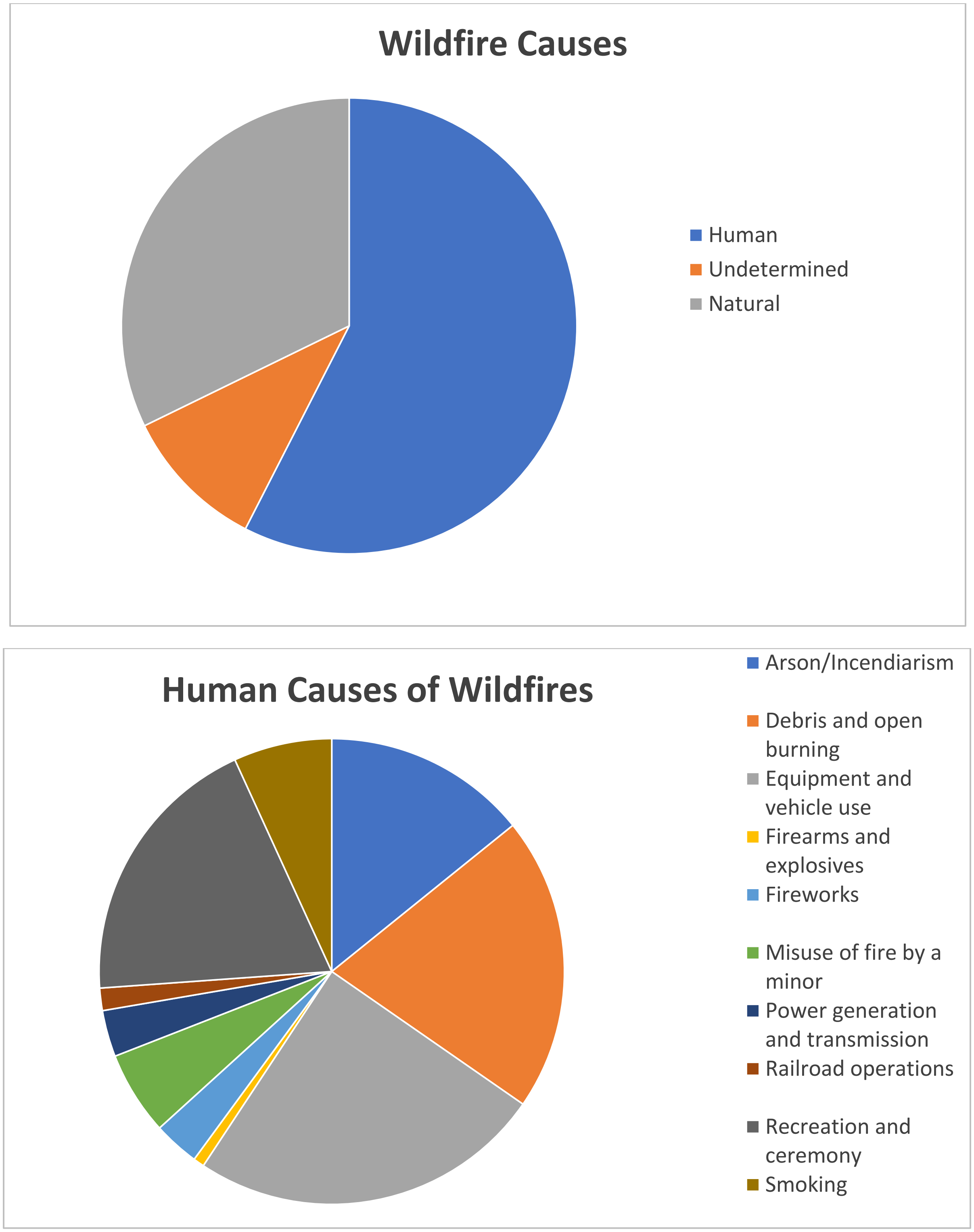


Figure 4.21-1. Most Common Causes of Wildfires, by Category According to the USDA Fire Program Analysis Fire-Occurrence Database (Source: Short 2014)

Table 4.21-1. Changes in Number of Fires and Fire Size, 2006–2020 versus 1992–2005

State	No. of Fires	Fire Size (acres)	EFFIS Classification (millions of acres)					
			Very Low	Low	Moderate	High	Very High	Extreme
California	9%	107%	-8%	0%	4%	4%	2%	8%
Nevada	-14%	38%	-7%	3%	6%	-1%	5%	16%
Utah	-5%	17%	-4%	7%	3%	-5%	-1%	21%
Oregon	-12%	147%	-2%	6%	2%	2%	0%	2%
Washington	8%	148%	-1%	2%	0%	2%	4%	-1%
Idaho	-26%	129%	-2%	5%	2%	1%	6%	10%
Montana	5%	90%	0%	5%	7%	1%	-15%	-24%
Colorado	127%	11%	-3%	10%	7%	-3%	-7%	2%
Wyoming	47%	28%	-2%	8%	8%	-2%	-7%	-11%
Arizona	10%	37%	-21%	3%	8%	4%	1%	14%
New Mexico	-27%	95%	-13%	8%	7%	0%	2%	25%

Increases in CFWI projected across Eastern California are in areas with a low burn probability, which suggests that meteorological conditions will be suitable for more fires, but the fuel source will not be available. However, areas in central Washington, northern Idaho, and eastern Arizona see an increase in both burn probability and CFWI, meaning that these areas should be placed under high scrutiny as they are the most susceptible to wildfire occurrence in the future.

To better understand these data, CFWI projections are converted into relative fire risk classes developed by EFFIS (San Miguel Ayanz et al. 2003). Trends are calculated in Table 4.21-1 by comparing total area of land in each state by class (very low, low, moderate, high, very high, and extreme). By mid-century, most states are projected to see increases in acreage classified as high, very high, and extreme, meaning that fires are likely to cause destruction over larger areas. States projected to see a decrease in the classifications are projected to see increases in acreage classified as low and moderate, suggesting still that those areas will still be susceptible to burning, but the burning will be less destructive.

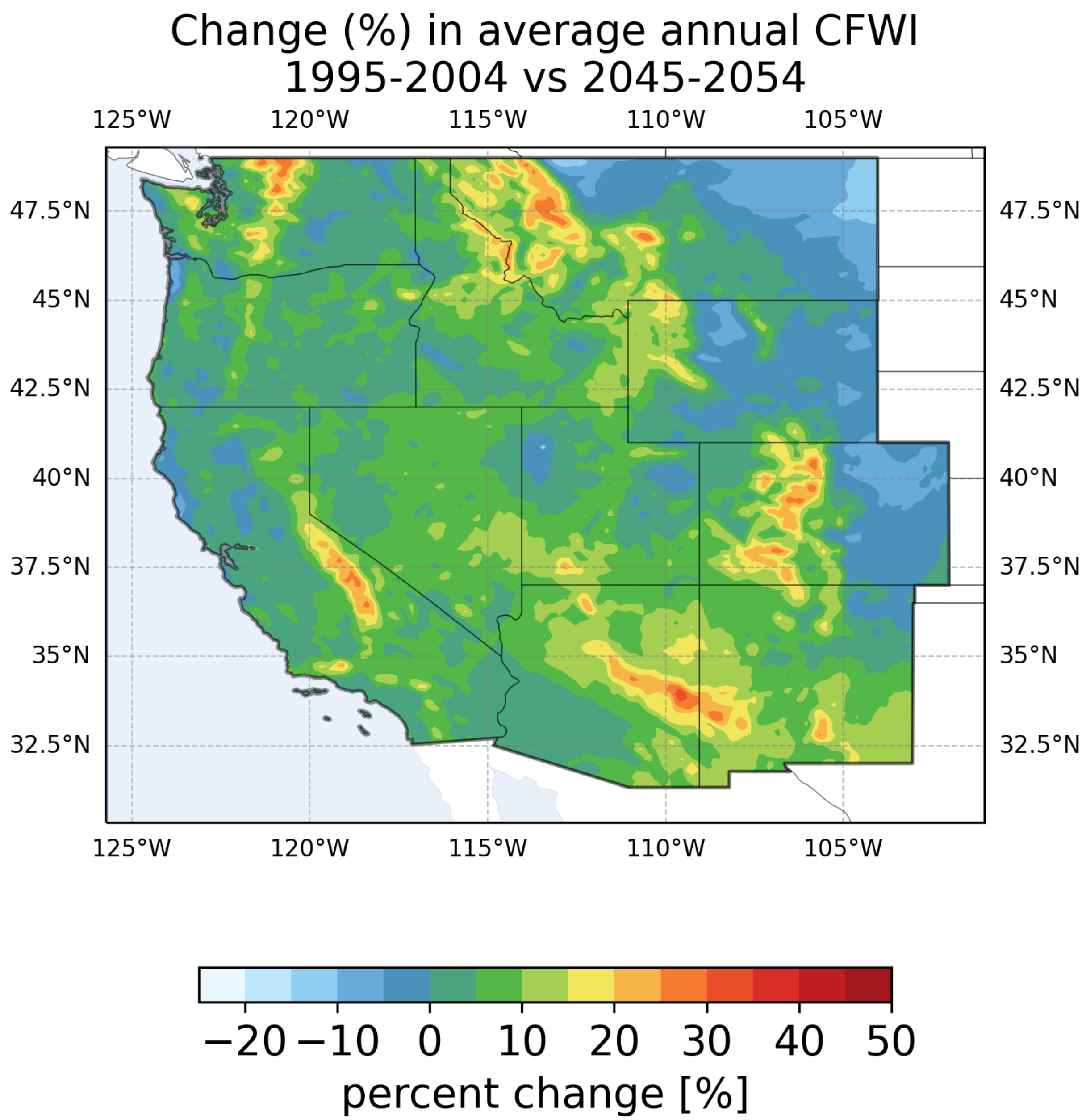


Figure 4.21-2. Percent Change in Annual Average CFWI Between Mid-century (2045–2054) and Historical (1995–2004) Periods

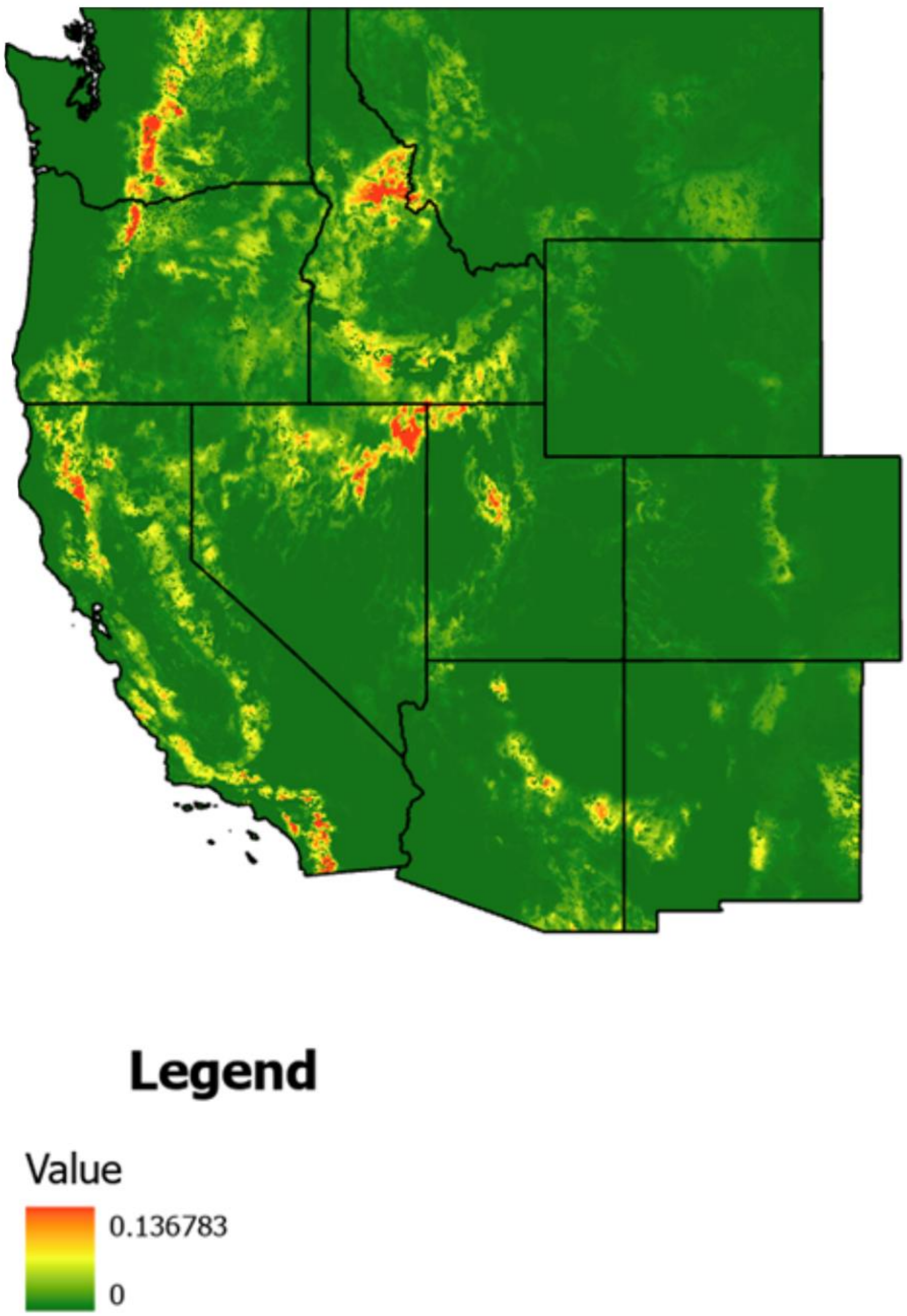


Figure 4.21-3. Burn Probability over the Planning Area (warmer shaded areas identify regions with a high probability of burning based on land conditions [circa 2020] and fire management practices; Short et al. 2020)

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5 Environmental Impacts

This chapter discusses potential environmental, social, and economic impacts of utility-scale solar energy development, both positive and negative. Only utility-scale PV facilities are evaluated because this solar technology is currently the most prevalent in the United States and globally. For example, since 2011 the BLM has only authorized PV facilities on BLM-administered lands (BLM 2023z).

This chapter includes resource-specific evaluations for the following:

- A broad range of potential direct impacts (resulting solely from the solar energy development, such as soil disturbance, habitat fragmentation, or noise generation) and indirect impacts (resulting from a related intermediate step or process, such as changes in surface water quality because of soil erosion at the construction site) for individual solar energy facilities and other infrastructure that might be required to support utility-scale solar energy development on BLM-administered lands, such as transmission facilities, roads, and BESSs;
- Cumulative impacts, both from the standpoint of cumulative impacts from all solar energy development on BLM-administered lands expected over approximately the next 20 years across the 11-state planning area (the reasonably foreseeable development scenario, or RFDS), and from solar energy development on BLM-administered lands considered in conjunction with other past, present, and reasonably foreseeable activities in the 11-state planning area (see Appendix J for activities and trends within the 11-state planning area); and
- Potential impacts across the alternatives (i.e., comparison of alternatives).

This impact analysis has informed the development of resource-specific required mitigation measures (programmatic design features), which are presented in Appendix B. For each resource, potential mitigation measures that could be used to avoid, minimize, and/or compensate for adverse impacts from solar energy development were identified through comprehensive review of PV solar energy development activities (as described in Chapter 3); review of published data regarding solar energy development mitigation measures; existing, relevant mitigation requirements from other programs and agencies (see Section 3.3.2.3); and BLM experience to date in permitting and monitoring PV solar energy facilities. Many of these measures are accepted practices known to be effective when implemented properly at the project level.

The revised design features proposed in Appendix B build on the *Final Programmatic EIS (PEIS) for Solar Energy Development in Six Southwestern States* ("the 2012 Western Solar Plan"; BLM and DOE 2012) design features, improving them through adding some new requirements, clarifying that all are required, indicating the responsible party, and providing a unique identifier for each design feature. Implementation of these design features will aid in avoiding, minimizing, and mitigating the potential impacts associated with solar energy development on BLM-administered lands. However, their applicability and effectiveness must be assessed at the project-specific level when the project location and design are known.

For the assessments in this chapter, the range of capacities in megawatts (MW) presented for solar energy facilities is 5 to 750 MW (see discussion in Section 3.1.2). The BLM occasionally has received applications for facilities with even higher capacities. Because of the modular nature of PV facilities the land and water use of larger facilities is proportional to their capacities, so impacts for facilities larger than 750 MW can be estimated using values given in Table 3.1-2 on a per-MW basis. The total RFDS is constant regardless of the size of individual facilities permitted.

In this chapter impacts from construction and operation of new transmission lines are described generically, without assumptions on the length of the new transmission lines or new roadways that would be required for solar energy facilities. Land disturbance impacts from transmission line upgrades that might be required are conservatively assumed to be similar to those from new transmission line construction. New transmission line construction within Section 368 corridors designated in the ROD for the *Programmatic EISfor Designation of Energy Corridors on BLM-Administered Lands in the 11 Western States* (DOE and DOI 2012) would be subject to Interagency Operating Procedures adopted for transmission lines in ROD Appendix B.

The resource-specific comparisons of alternatives presented in this chapter are an important component supporting the BLM's selection of the preferred alternative (Section 2.5). Components of alternatives to note include:

- For each of the resource areas, impacts already exist under the No Action Alternative, which represents the BLM's ongoing program for reviewing and permitting PV solar energy development projects, and includes designated priority development areas, variance areas, and exclusion areas, as well as an extensive set of design features.
- The 2012 Western Solar Plan contained various resource-based exclusions in the six states addressed in that effort (BLM and DOE 2012). Under all of the Action Alternatives, these resource-based exclusions were generally retained (and updated to clarify) and applied in determining the areas available for and excluded from application in the five new states considered (Idaho, Montana, Oregon, Washington, and Wyoming). As such, these updated resource-based exclusions are expected to reduce impacts of utility-scale solar energy development in these five states.
- Under all Action Alternatives, existing priority development areas(330,195 acres) would be available for utility-scale solar ROW application, except for Los Mogotes SEZ in Colorado. All Action Alternatives propose deallocating the Los Mogotes SEZ ("undesignating"). The area of the Los Mogotes SEZ has been found to be unsuitable for utility-scale solar energy development based on Tribal concerns.
- Priority development areas have the same potential for development under the No Action Alternative and the Action Alternatives, because prioritization of ROW

application processing and other incentives for development within these areas would remain unchanged from those included under the 2012 Western Solar Plan. These areas are included in the areas presented as available for utility-scale solar ROW application under the Action Alternatives analyzed here. Over time, priority areas may be added, eliminated, or modified through land use plan amendments.

- Given increased demand for solar energy development and the nation's renewable energy goals the BLM estimates that approximately 700,000 acres of BLM-administered lands will host utility-scale PV solar energy development over the next 20 years (see Section 2.3, Appendix C). This level of development is expected to occur both under the No Action Alternative and the Action Alternatives. The Action Alternatives are intended to help the BLM, communities, and utility-scale solar developers by directing future development to the most suitable BLM-administered lands for such development. As compared to the No Action Alternative, each of the Action Alternatives would helpfocus development in areas avoiding resource conflicts and/or areas in which development may be more likely to be economically feasible and technologically viable.
- Each alternative would make more land available for utility-scale solar energy development than the approximately 700,000 acres estimated to be needed to meet the demand for solar energy development on public lands through 2045. Alternative 1 would make more lands available for application than are currently available under the No Action Alternative, and the most available land amongst the Action Alternatives. Alternatives 2 through 5 would make progressively less land available for development by applying resource-based exclusions and concentrating available lands near transmission infrastructure or previously disturbed areas (or both). Making less land available may make it more difficult for solar developers to identify financially and technologically suitable project locations and may also increase the potential for conflicts with other prospective land uses competing for certain areas (e.g., grazing, mining, recreation). Further, alternatives with relatively less land available for solar application may result in fewer than the estimated 700,000 acres of solar energy development or a shift of future development from public to private lands. This would in turn lead to fewer overall impacts from solar energy development on public lands, though some development and associated impacts could be relocated to private or non-public lands. However, the likelihood of the Action Alternatives with limited available lands constraining solar energy development is diminished by the fact that the remaining available lands would be in areas more likely to be suitable for solar energy development, less likely to present resource conflicts, or both. This ensures a more efficient permitting process for applications. For example, Alternatives 3, 4, and 5 would concentrate solar energy development near existing or planned transmission infrastructure or on previously disturbed lands (or both) where current and past development is already more prevalent, while avoiding intact habitat and connectivity corridors for wildlife and SSS. The objective of considering and avoiding key resources at a programmatic level is to inform intelligent siting decisions and minimize issues requiring consultation at

the project-specific level. In summary, the quantity of available lands and corresponding exclusion areas for each alternative may yield either adverse or beneficial impacts, depending on the specific resource under evaluation, as described further below.

- The updated design features proposed under the Action Alternatives are more specific and prescriptive than those under the 2012 Western Solar Plan. As such, the Action Alternatives would further minimize the environmental impacts of utility-scale solar energy development, as compared to the No Action Alternative.
- For many resource and concern areas (i.e., vegetation, wildlife, SSS, EJ, paleontological resources, livestock grazing, wild horses and burros), quantitative assessments of potential differences in impacts or impact areas has been conducted; these are presented in the corresponding sections of this chapter.
- For some resources (e.g., air quality, geologic setting and soil resources, hydrology, lands and realty), the scale and scope of this programmatic 11-state analysis, along with limited data across the planning area, preclude a quantitative analysis of the intersections between lands identified as available for application and lands with conflicts for the resource areas analyzed. The primarily qualitative analysis presented for comparison of the Action Alternatives for these resources is sufficient to inform the programmatic decisions to be made, which are primarily planning-level decisions (i.e., allocation and exclusion decisions). Additional quantitative analysis would be performed, as appropriate, during project-specific NEPA review.
- The analyses in this chapter concluded that for some resource and concern areas (i.e., acoustic environment, hazardous materials and wastes, health and safety, military and civilian aviation), the impacts would be similar across all Action Alternatives and the No Action Alternative.
- For certain resources, descriptions of acres of lands available for application and exclusion areas are approximated and are based either on the overall estimates of acres by alternative described in Table 2.1-2, or on resource-specific estimates of alternative impacts described in the respective sections of this chapter.

5.1 Acoustic Environment

5.1.1 Direct and Indirect Impacts

5.1.1.1 Site Characterization

Typically, potential noise impacts from site characterization activities would be negligible because these activities are short-term, generate minimum noise, and can be conducted with a small crew and small equipment. Albeit rare for PV development, in some instances deep soil corings may be required to obtain information necessary for the design of substantial structure foundations or extensive drilling for installation of monitoring/sampling wells and piezometers for onsite groundwater characterization.

These activities could generate substantial noise, and they also could require larger equipment with larger access road requirements. However, potential noise impacts of these site characterization activities on neighboring communities would be much lower than those of construction activities. Also, developers might elect to delay site characterization activities that would result in more extensive impacts until the construction phase of development, especially if these activities do not play a critical role in determining facility design or establishing PPAs (power purchase agreements).

5.1.1.2 Construction

Construction activities could involve a number of separate operations, as described in Section 3.2.3. Potential noise impacts of facility construction on nearby communities would vary depending not only on the technology used but also on many other variables—power generation capacity, land area of a facility, construction period, topographic features (including terrain and vegetation), soil characteristics (including crustiness and soil strength), local meteorological conditions (ambient temperature, relative humidity, and vertical wind and temperature profiles), distance to the site boundaries, and nearest sensitive human receptors.

Construction would, in large part, be divided into two phases—site preparation and site construction.[1] Major heavy equipment potentially used in the site preparation phase may include chain saws, mowers, stump pullers/rotary rakes, chippers, dozers, scrapers, end loaders, trucks, cranes, rock drills, and equipment for blasting, if required. The major equipment used in the site construction phase could include cranes, end loaders, backhoes, dozers, trucks, and piledrivers (e.g., vibratory piledrivers).

Sources of noise would be from a variety of standard construction activities. Noise levels from construction would vary with the level of activity, number of pieces of equipment operating, and the location and type of activity. For typical construction projects, noise levels would be highest during the site preparation phase, that is, the early phase of construction when most of the noisy and heavy equipment would be used for land clearing, grading, and road construction over a short time period.

During construction, the commuter/delivery/support vehicular traffic around the facility and along the traffic routes would generate intermittent noise. However, the noise from these sources would be limited to the immediate vicinity of the traffic route and would be minor in comparison with the contribution from continuous noise sources, such as dozers.

In general, the dominant noise source for most construction equipment is the diesel engine if used without sufficient muffling. However, in cases where pavement breaking and/or impact pile driving would be involved, these noises would dominate. Average noise levels for typical construction equipment range from 76 dBA for a concrete vibrator or saw to 101 dBA for an impact piledriver at a distance of 50 ft (15 m) from a

[1] The site construction phase includes all activities after site preparation to the onset of operation, such as assembly and installation of solar panels, and building administrative, maintenance, storage, and service facilities, as well as pipelines and transmission lines.

source (Quagliata et al. 2018). Noise levels of other construction equipment range from 76 to 90 dBA at a distance of 50 ft (15 m).

Maximum noise levels near the construction site would be approximately 95 dBA. Considering geometric spreading and ground effects, as explained in Appendix F.1.2.1, noise levels would attenuate to about 40 dBA (typical of daytime rural background levels) at a distance of 1.2 mi (1.9 km) from the construction site. If a 10-hour daytime work schedule is considered, the EPA guideline level of 55 dBA Ldn for residential areas (EPA 1974) would occur at about 1,200 ft (370 m) from the construction site, which would be mostly within the facility boundary. Most construction activities would occur during the day, when noise is better tolerated than at night because of the masking effects of background noise. Nighttime noise levels would drop to the background levels of a rural environment because construction activities would cease.

Most utility-scale PV facilities over the 11 western states would be sited in a dry climate with abundant sunshine and low humidity albeit relatively low temperature and/or high humidity in winter months. Mid- and high-frequency noises (e.g., those generated from construction activities) are substantially attenuated by atmospheric absorption under high-temperature and low-humidity conditions that are often typical for utility-scale PV facilities. In addition, considering other attenuation mechanisms, e.g., upward refraction of sound during daytime hours, noise attenuation to background levels would occur at distances of far less than aforementioned distances from the construction site. Development of a strong temperature inversion, which would produce downward refraction of sound and as a result better audibility of distant sounds, is frequent in winter with calm winds, clear skies, and long nights. Thus, for construction activities occurring in the early morning (before or just after sunrise) the noise can travel farther than aforementioned distances. However, in general, the inversion would then dissipate within about 2–3 hours after sunrise.

For larger solar PV facilities (e.g., >300 MW), construction activities would last about 2 to 3 years, or 4 at most, and best engineering practices for construction noise control would be implemented in accordance with applicable laws, ordinances, regulations, and standards. For PV facilities located in remote and sparsely populated areas, potential noise impacts on surrounding communities would be minor and temporary in nature. Site-specific assessment of noise impacts from construction activities would be required as a part of ROW application processing.

Depending on the equipment and methods employed, varying degrees of ground-borne vibration would occur in the immediate vicinity of construction sites. In general, no major vibration-causing construction equipment (e.g., impact piledrivers) would be used in constructing PV facilities. As a rule, for PV facilities located in relatively remote areas far from vibration-sensitive structures, potential vibration impacts on surrounding communities and vibration-sensitive structures would likely be negligible. For example, the vibration level at receptors beyond 214 and 539 ft (65 and 164 m) from a typical and upper-range sonic piledriver (93 and 105 VdB at 25 ft [7.6 m]), respectively, would diminish below the threshold of perception of 65 VdB for humans, as discussed in Section 4.1.2 (Quagliata et al. 2018). This vibration level would be limited mostly to within the construction site. A site-specific assessment of vibration impacts from construction activities would be required as a part of ROW application processing.

5.1.1.3 Operations and Maintenance

Noise-generating activities common for PV facilities during operations and maintenance include those from site inspection; solar tracking devices; electrical devices, such as inverters and transformers; maintenance and repair (e.g., panel washing, replacement of broken panels) at the solar field; commuter/support/delivery vehicles within and around the solar energy facility; and noise from control/administrative buildings, warehouses, and other auxiliary buildings/structures.

Typically, solar tracking systems make little noise and are relatively unobtrusive. To dissipate heat from solar module assemblies, passive convection cooling systems or active air- or liquid-cooling systems would be applied. Noise sources for active air-cooling systems would be electric fans, while sources for active liquid-cooling systems would be electrically powered pumps.

Electrical-related noise sources would include pad-mounted inverters, which convert DC into alternating current (AC). The audible noise level of an inverter (attributable to the cooling fan) with a rated capacity of 10 kW would be as low as 35 to 40 dBA or lower at a distance of about 3 ft (1 m), but would exceed 50 dBA for some inverters with rated capacities greater than 10 kW (Ishikawa 2002). However, the noise level from these higher capacity inverters would be less than 30 dBA at a distance of 50 ft (15 m). Many inverters would be located among the modules of a PV facility. The combined noise level from these inverters is not expected to result in adverse noise impacts at the site boundary or at the nearest residential locations.

The transformers at PV facilities are typically located near the site boundary. The primary transformer noise is a constant low-frequency humming tone with a fundamental frequency of 120 Hz and even harmonics of line frequency of 60 Hz primarily because of the vibration of its core (Wood and Barnes 2006). Frequencies of 240 Hz, 360 Hz, and up to 1,200 Hz or higher are common. The core's tonal noise is uniform in all directions and continuous when in operation. In addition, cooling fans and oil pumps at large transformers produce broadband noise from the cooling system fan and pump when in operation; however, this noise is usually less noticeable than tonal noise. The number and capacity of transformer(s) and their configurations could vary with many factors (e.g., solar technology, facility design, and redundancy). The average A-weighted core sound level at a distance of 150 m (492 ft) from a transformer would be about 51 dBA for 938 million volt-amperes, assuming a power factor of 0.8 for a 750-MW solar energy facility (Wood and Barnes 2006). For geometric spreading only, the noise level at a distance of about 1,800 ft (550 m) would be about 40 dBA, typical of the daytime rural background level. When accounting for other attenuation mechanisms (such as ground effects and air absorption) and/or for facilities with capacities of less than 750 MW, daytime rural background levels generally would occur at distances of less than 1,800 ft (550 m) from the site. Because PV facilities have a minimal number of noise sources and generate only low-level noise during operation, noise impacts of PV facilities on neighboring communities would be minimal.

During operation, no major equipment that can cause ground vibration would be used. All equipment would be designed to minimize the vibrations caused by the imbalance of moving parts. If needed, vibration-monitoring systems, which are designed to ensure that the equipment remains balanced, would be installed on the equipment. Potential vibration impacts on surrounding communities and vibration-sensitive structures during operation of a PV facility would be minimal.

5.1.1.4 Decommissioning/Reclamation

Decommissioning requires many of the same procedures and equipment used in traditional construction. Decommissioning would include dismantling of solar energy facilities and support facilities such as buildings/structures and mechanical/electrical installations, disposal of debris, grading, and revegetation as needed. Activities for decommissioning would be similar to those for construction but on a more limited scale. Potential noise impacts on surrounding communities would be correspondingly less than those for construction activities. Decommissioning activities would last for a short period, and their potential impacts would be minor and temporary in nature. The same mitigation measures adopted during the construction phase could also be implemented during the decommissioning phase.

Potential vibration impacts on surrounding communities and vibration-sensitive structures during decommissioning of a PV solar energy facility would be less than those during construction and thus minimal.

5.1.1.5 Transmission Lines and Roads

The general sequence of construction activities for electric transmission lines is described in Section 3.2.6. Potential noise impacts during construction of transmission corridors and during line upgrade activities would occur during ground disturbance and excavation to clear the ROWs from installation of access roads, staging areas, and structures (e.g., transmission line towers, substations, or pipelines), and from installation of the support structures and lines. Major noise sources would be heavy equipment, such as piledrivers, concrete mixers, cranes, dozers, or graders to level the foundation area, and vehicular traffic, such as heavy trucks. Depending on environmental and/or logistical factors (e.g., rugged, mountainous terrain), helicopters could be used for transport and erection of steel lattice towers and/or poles. This helicopter operation could substantially reduce the construction period and total noise exposure, although short-term noise levels would be higher along flight routes and around the tower sites when in operation. Helicopter noise at 1,000 ft ranges from 62 to 84 dBA, comparable to or lower than other heavy equipment or vehicles at representative distances, typically 50 ft (NASEM 2016). However, helicopter noise has an impulsive character and could travel farther than noise sources near the ground because it is not affected by ground effects.

Noise impact distances to the noise regulations/guideline levels during construction of transmission lines would be similar to those during construction in Section 5.1.1.2. Most construction activities would occur during the day, when noise is better tolerated than at night because of the masking effects of background noise. Nighttime noise levels would generally drop to background levels. Since most new facilities would be located within a few miles and up to 10 mi (16 km) from existing transmission lines, transmission line construction could generally be performed in a relatively short time period (e.g., a few months). In addition, construction sites along the transmission line ROWs would move continuously, and no particular area would be exposed to noise for a prolonged period. Thus, the potential noise impacts on surrounding communities along the transmission line ROW, if any, would be minor and temporary.

During operation of the transmission lines, there is a potential for noise impacts from corona discharge, which relates to the electrical breakdown of air into charged particles caused by the electrical field at the surface of conductors. Corona discharge is affected by ambient weather conditions, such as humidity, air density, wind, and precipitation, and by irregularities on the energized surfaces. Corona-generated audible and high-frequency noise from transmission lines is generally characterized as having a crackling, popping, or hissing noise but does not have any significant adverse impacts on humans, except for potential annoyance.

Modern transmission lines are designed, constructed, and maintained so that they operate below the corona-inception voltage during dry conditions, meaning that the lines generate a minimum of corona-related noise. During rainfall events (when corona discharge is highest), the noise level at 100 ft (30 m) from the center of a 250-kV and a 500-kV transmission line tower would be about 36 and 47 dBA, respectively (Lee et al. 1996). The noise level at a distance of 300 ft (91 m) would be about 31 and 42 dBA, respectively. However, noise from corona discharge during fair-weather conditions is generally indistinguishable from background noise.

Many of the areas adjacent to the BLM-administered lands are undeveloped and sparsely populated. Except for very quiet locations, corona noise would likely not be discernible beyond 0.25 mi (0.4 km) from a transmission line, even in rainy conditions.

A preliminary study by Pearsons et al. (1979) indicated that corona noise needed to be 10 dBA lower in intensity than other environmental noises judged equally as annoying because of its more annoying high-frequency components. However, at long distances, noise attenuation by air absorption is significant, especially at high frequencies; thus, corona noise decreases faster than other environmental noise sources that are dominated by lower frequencies. Accordingly, corona noise is easily lost in background noise within short distances from transmission lines.

As discussed in Section 5.1.1.4, activities for decommissioning would be similar to those for construction but on a more limited scale and duration. Decommissioning activities would last for a shorter period than construction activities, and their potential impacts would be minor and temporary. However, for breakup of concrete footings, high-power tools such as jackhammers or hydraulic hammers would be needed in a short duration, which generate higher ground vibration than any other activities. Except this, overall, during the life of transmission lines (i.e., construction, operation, and decommissioning), no major equipment that can cause significant ground vibration would be used. Potential vibration impacts on surrounding communities and vibration-sensitive structures during the life of transmission lines would be minimal.

5.1.2 Cumulative Impacts

Noise during PV solar energy facility operations would generally be low because PV facilities, which have no large stationary sources, light worker traffic, and only occasional delivery and maintenance traffic, produce little noise. Since noise related to large PV solar energy facilities can travel over short distances and construction noise is temporary, contributions to cumulative noise impacts are expected to be minor.

Under the RFDS, the BLM estimates that a total combined area of approximately 700,000 acres of BLM-administered lands and 600,000 acres of other lands (including private lands and state-owned lands) across the 11-state planning area will host utility-scale PV solar energy development over the next 20 years. The RFDS land-use projections would affect a relatively small proportion of total BLM-administered lands in the 11-state planning area; however, cumulative impacts could occur from other activities in the region, including other solar, wind, and geothermal energy development, oil and gas mining, and construction of transmission lines and pipelines. Design features under the BLM Action Alternatives to address noise during construction include limiting the daily hours of activities, construction of noise barriers if needed and practicable, and coordination with nearby residents.

5.1.3 Design Features

The BLM has identified design features that will be requirements for all utility-scale solar energy projects on BLM-administered lands subject to the ROD for this Programmatic EIS. The list of design features that have been identified to avoid, minimize, and/or compensate for potential impacts on the acoustic environment from solar energy development can be found in Appendix B.1.

5.1.4 Comparison of Alternatives

5.1.4.1 No Action Alternative

Under the No Action Alternative, approximately 47.3 million acres of BLM-administered lands would be available for applications for solar energy development. Of the total lands available for application, 330,195 acres are located within existing priority areas, approximately 15.7 million acres are variance lands allocated in the 2012 Western Solar Plan for the six-state planning area, and approximately 31.6 million acres would be available for application within the five additional states considered in this Programmatic EIS, as these lands were not addressed in the 2012 Western Solar Plan. Of the open available lands, under the RFDS the BLM estimates that approximately 700,000 acres (1.,4%) of BLM-administered lands will host utility-scale PV solar energy development over the next 20 years. Acoustic impacts described in Section 5.1.1 could occur from the construction, operation, and decommissioning of PV solar energy facilities under the No Action Alternative. In the six states addressed under the 2012 Western Solar Plan, the design features from that plan would mitigate acoustic impacts. In the five new states, required mitigation measures for acoustic impacts would be established at the project-specific level.

5.1.4.2 Action Alternatives

Alternative 1. Approximately 55 million acres of BLM-administered lands would be available for utility-scale solar application.

Alternative 2. Approximately 36.2 million acres of BLM-administered lands would be available for utility-scale solar application.

Alternative 3. Approximately 22.2 million acres of BLM-administered lands would be available for utility-scale solar application.

Alternative 4. Approximately 11.2 million acres of BLM-administered lands would be available for utility-scale solar application.

Alternative 5. Approximately 8.4 million acres of BLM-administered lands would be available for utility-scale solar application.

The RFDS estimates that solar energy development would occur on approximately 700,000 acres within BLM-administered lands available under Alternatives 1 through 5. Acoustic impacts described in Section 5.1.1 may occur from the construction, operation, and decommissioning of PV solar energy facilities under the Action Alternatives. The magnitude of impacts on the acoustic environment from development to the RFDS level on BLM-administered lands within the planning area is expected to be low and similar under all of the Action Alternatives. Updated and more prescriptive design features may reduce the magnitude of impacts on the acoustic environment in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

5.2 Air Quality and Climate

Solar energy development could affect air quality and climate in the areas where it occurs as well as in areas that would benefit from reductions in emissions due to reduced use of fossil fuel energy. Direct, indirect, cumulative impacts, mitigation measures, and comparison of alternatives are evaluated in two separate categories in the following subsections: Section 5.2.1 evaluates impacts on air quality, and Section 5.2.2 evaluates impacts on climate.

5.2.1 Air Quality

5.2.1.1 Direct and Indirect Impacts

5.2.1.1.1 Site Characterization

Typically, potential air quality impacts from site characterization activities would be negligible because these activities are short-term, require minimum site disturbance, and can be conducted with a small crew and small equipment. Albeit rare for PV development, in some instances, deep soil corings may be required to obtain information necessary for the design of substantial structural foundations or extensive drilling for the installation of monitoring/sampling wells and piezometers for onsite groundwater characterization (see Section 3.2). These activities could require substantial ground disturbance and also large equipment with large access road requirements. However, the potential impacts of these site characterization activities on ambient air quality would be much lower than those of construction activities. Also, developers might elect to delay site characterization activities that would result in more extensive impacts until the construction phase of development.

5.2.1.1.2 Construction

Construction activities could involve a number of separate operations, including mobilization/staging, land clearing (grubbing and tree removal), topsoil stripping, cut-and-fill operations (i.e., earthmoving), road construction, ground excavation, drilling and blasting if required, foundation treatment, building/structure erection, electrical and mechanical installation, and landscaping. Construction would be divided, in large part, into two phases—site preparation and site construction.[2] For most utility-scale PV facilities, the site preparation phase would be of relatively short duration (e.g., a few months) followed by a much longer construction phase (e.g., a few years for a large PV facility).

Major heavy equipment potentially used in the site preparation phase would include chain saws, stump pullers/rotary rakes, chippers, dozers, scrapers, end loaders, trucks, cranes, rock drills, and equipment for blasting operations if required. The major equipment used in the site construction phase could include cranes, end loaders, backhoes, dozers, and trucks.

Fugitive dust from soil disturbances and engine exhaust from heavy equipment and commuter/delivery/support vehicular traffic within and around the facility would contribute to air emissions of criteria pollutants (e.g., NO_x, CO, particulat matter [PM]), volatile organic compounds (VOCs), GHGs (e.g., CO_2), and a small amount of hazardous air pollutants (HAPs; e.g., benzene). Typically, potential impacts of fugitive dust

[2] The site construction phase includes all activities after site preparation to the onset of operation, e.g., assembly and installation of solar panels, building administrative, maintenance, storage, and service facilities as well as pipelines and transmission lines.

emissions on ambient air quality would be higher than those of engine exhaust emissions due to relatively large amounts of emissions and ground-level releases.

For PV facilities located in remote areas (expected to be the case for most facilities on BLM-administered lands), construction activities would probably contribute minimally to concentrations of air pollutants at the closest residences or businesses. However, under unfavorable dispersion conditions, infrequent high concentrations of PM10 or PM2.5 (particulate matter with an aerodynamic of 10 μm or less, or 2.5 μm or less, respectively) could exceed state or federal standards at the site boundaries. To address these circumstances, BLM permit stipulations and most state construction permits include requirements that mitigation measures be employed to reduce fugitive dust emissions.

Particularly in areas with highly erodible soils, such as sandy soils (see Section 5.6.1), fugitive dust from construction could cause unavoidable impacts for the duration of the site preparation and construction phases (a few years). In areas with more stable soils, e.g., areas covered with non-erodible elements such as stone or vegetation, dust emissions would be comparatively less. Fugitive dust emissions would be caused by site preparation, construction activities, and wind erosion, and would cause unavoidable localized impacts. Construction activities at any given time would be limited to a portion of the site and would occur during daytime when conditions generally favor dispersion of dust, both of which would reduce impacts. However, a large portion of the total construction area of larger PV facilities (e.g., several hundred acres or more) could be exposed to wind erosion. Stabilizing soils in the disturbed areas at the completion of construction would reduce these emissions. However, given that stabilization of certain soil types in dry climates is not fully effective, wind erosion from disturbed areas could continue throughout the remainder of the construction period and beyond into the operation and reclamation phases, particularly in locations with the highly erodible soils. Direct emissions from construction activities and the persistent wind erosion from disturbed soils remaining after completion of construction need to be addressed in site-specific assessments during the ROW application process to gauge the potential severity of these impacts and develop appropriate mitigation measures. More recent BLM permitting of projects includes requirements for minimizing soil disturbance. These requirements would also reduce erosion of soils and corresponding fugitive dust impacts.

5.2.1.1.3 Operations and Maintenance

In general, air emissions associated with generating electricity from solar PV facilities are negligible because no fossil fuel is used to generate this electricity. Emissions from the solar fields would include fugitive dust and engine exhaust emissions from vehicles and heavy equipment associated with regular site inspections, maintenance activities (e.g., panel washing, replacement of broken panels), and wind erosion from bare ground and access roads. In addition, engine exhaust from commuter/delivery/support vehicular traffic would also contribute emissions within and around the PV facility. The types of emission sources and pollutants would be similar to those during construction, but the amounts would be far smaller and generally insignificant because of the low number of workers present during operations.

Fugitive dust emissions from wind erosion and vehicle travel could cause impacts during operations as well as during construction. Particularly for larger PV facilities (e.g., several hundred acres or more), wind erosion during operation needs to be addressed in site-specific assessments during the ROW application process to assess the severity of these impacts. Traffic from workers, deliveries, and support is expected to be minimal during operations, with correspondingly small emissions. Emissions could be reduced by treating or surfacing roads and parking areas, particularly in areas with highly erodible soils, and by requiring vehicles to use roadways whenever possible. Although not large, emissions from vehicle travel should be addressed as a component of the site-specific assessments.

Current policies accelerating PV deployments are motivated by environmental goals toward net-zero GHG emissions by 2050, to be partially achieved by displacing electricity generated from fossil fuels. Energy markets are complex, and the net effects of production changes in one location or one sector are affected by multiple factors in the broader energy market. The increase in PV-generated electricity in this 11-state planning area may lead to a decrease in demand for fossil-fuel generated electricity, a decrease in demand for other renewable electricity sources, or increase the overall market supply of electricity to meet increased demand. These three effects are likely to occur in some combination, but the relative contribution of each depends on many factors. To the extent that the solar-generated electricity displaces electricity generated by fossil fuels facilities in the same region, operation of the PV facilities may reduce regional emissions of combustion-related pollutants. This would improve air quality locally and/or in the region of the fossil-fuel facilities.

Table 5.2.1-1 provides emission factors associated with the generation of 1 MWh of electricity from combustion (fossil fuel–fired) electricity generation facilities. Fossil energy emission factors were estimated on the basis of total annual emission factors and the annual power generation for all types of fossil fuel–fired power plants currently in operation in the 11-state planning area (EPA 2023j). PV facility emissions were assumed to be zero because no fossil fuel is used for electricity generation.

Table 5.2.1-1. Composite Emission Factors from Combustion-Related Power Generation in the 11-State Planning Area

Composite Emission Factor	lb./MWh[a]
SO_2	0.41
NO_x	1.01

[a] Composite emission factors for 11-state planning area based on individual state composites weighted by the power generated in each state (EPA 2023j).

The emission factors in Table 5.2.1-1 do not account for potential market substitution effects due to changes in electricity prices. They do provide a useful upper bound on potential emissions avoided. The actual emissions avoided are expected to be less than indicated by the emissions factors. Combustion-related emission factors by state and composite emission factors along with electricity generation in 2021 are presented in Appendix F, Table F.2.3-1.

Estimates of potential air pollutant emissions displaced by operation of a hypothetical 750-MW PV facility are presented in Table 5.2.1-2 for criteria air pollutants such as SO_2 and NO_x. Power generation capacities for individual solar facilities ranging from 5 to 750 MW were assumed for the analysis. The estimated maximum emissions avoided depend only on the megawatt-hours (MWh) of fossil fuel–generated power potentially displaced, because a composite emission factor per MWh of power from combustion (fossil fuel–fired) technologies is assumed (EPA 2023j). The upper bound on avoided emissions for a single 750-MW PV facility would be up to 0.46% of total emissions from electric power systems in the 11-state planning area. When compared with all source categories, power production from the same PV facility would displace up to 0.11% of SO_2 and 0.05% of NO_x in the 11 states (EPA 2023j). Actual displacement will be less and depends on the market effects of increased solar generation.

Table 5.2.1-2. Potential Pollutant Emissions Avoided for Individual PV Solar Energy Facilities from Displacement of Combustion-Related Power Generation

<table>
<tr><th rowspan="2">Capacity (MW)</th><th rowspan="2">Annual Generation (GWh/yr)[a]</th><th colspan="2">Emissions Displaced (tons/yr)[b]</th></tr>
<tr><th>SO_2</th><th>NO_x</th></tr>
<tr><td>5–750[c]</td><td>12.1–1,807</td><td>2.5–374</td><td>6.1–912</td></tr>
<tr><td rowspan="2">% of total emissions from 11 states</td><td>Electricity generation in 2021[d]</td><td>0.003–0.46</td><td>0.003–0.46</td></tr>
<tr><td>All sources in 2020[e]</td><td>0.0007–0.11</td><td>0.0004–0.05</td></tr>
</table>

[a] Used a composite capacity factor of 27.5%, averaged over 11-state planning area in 2021. Note that higher capacity factors than the composite capacity factor occur in some of the southwestern states (e.g., Arizona, California, or Nevada).

[b] See Table 5.2-1 for 11-state composite emission factors.

[c] See assumptions provided in Section 3.1.2. The range of facility capacities is based on the capacities of approved facilities on BLM-administered lands through 2022. The BLM has received ROW applications for larger facilities up to 4000 MW; air quality impacts can be scaled on a per-MW basis.

[d] Data are taken from the EPA's *eGrid* database.

[e] See Table 4.2-3.

Source: EIA (2023b,c); EPA (2023j).

For the analysis, a PV facility average capacity factor of 27.5% is used (EIA 2023b,c). Capacity factors slightly higher than this value occur in southwestern states (e.g., Arizona, California, Nevada), while factors lower than this occur in northern states (e.g., Montana, Washington), as shown in Appendix F, Table F.2.3-2. Therefore, benefits from emissions avoided could vary from state to state based on the location of fossil fuel generation that may be reduced. In addition, combustion-related power plants are typically baseload power providers, while PV facilities are generally intermittent sources, although this intermittency is beginning to be avoided through use of BESSs. This comparison of emissions avoided by PV facilities acknowledges that the different types of plants serve different functions and are located in different places.

Potential impacts on ambient air quality associated with operation of a PV facility would be negligible. As shown in Table 5.2.1-2, displaced emissions even for a single large PV facility could be fairly substantial.

5.2.1.1.4 Transmission Lines and Roads

The construction of transmission lines within a designated ROW to connect new solar energy projects to the nearest regional grid, or the upgrading of existing lines, would result in measurable air emissions. The general sequence of activities for placing electricity transmission lines would involve surveying, land clearing (grubbing and tree removal), construction of access roads, drilling or excavation for support structures and concrete footings, backfilling, tower erection and powerline stringing.

Tower structures would be carried to the site by truck in sections, assembled in laydown areas, and lifted into place with a crane. In limited circumstances, helicopters can be used for transmission line construction. To minimize fugitive dust emissions from helicopter operations, paved or vegetated areas near a major highway could be selected as staging areas, and if feasible, water spraying could be used on the area where the transmission tower was being erected. Typically, the helicopter would operate 100 ft (30 m) above the erection site. Dust emissions would be less than those associated with landings and takeoffs, for which dust begins to be raised at operating heights below about 50 ft (15 m), and would also be less than those raised by long-distance truck traffic on unpaved roads. As in other construction activities, most of these activities would include fugitive dust emissions from soil disturbance and engine exhaust emissions from heavy equipment and commuter/delivery/support vehicles. Standard dust control measures (e.g., frequent water spraying on disturbed areas) would be implemented. For simple projects requiring minimal access road construction and ROW amendments, construction of 5 mi (8 km) of transmission line would likely require a minimum of six months. Actual construction time could exceed 1 year for more constrained projects and/or those on higher-sloped lands. Construction sites along transmission line ROWs would move continuously, so the duration of air impacts in a particular area would be limited. Thus, the potential impacts on ambient air quality from transmission line construction would generally be minor and temporary.

The operations phase associated with transmission lines would generate low levels of criteria pollutants, VOCs, GHGs, and HAPs from activities such as motor vehicle operation during periodic site inspection. For some sites, vehicles and other gasoline-powered equipment would be required to perform vegetation maintenance within the ROW. (Sites with slow vegetation growth or where grazing is used for vegetation management rather than mowing are exceptions.) Other maintenance activities would include the repair or replacement of tower/pole components or conductors/insulators, painting of towers/poles, and emergency response (e.g., during power outages) as needed. In addition, transmission lines could produce minute amounts of O_3 and NO_x associated with corona discharge (i.e., the breakdown of air near high-voltage conductors). Corona discharge is most noticeable for high-voltage lines during rain or fog conditions when the ambient O_3 concentration is typically at its minimum. All these emissions during the operation phase would be quite small, and therefore potential impacts on ambient air quality would be negligible.

5.2.1.1.5 Decommissioning/Reclamation

Decommissioning would include the dismantling of solar energy facilities and support facilities, such as buildings/structures and mechanical/electrical installations; disposal of debris; grading; and revegetation as needed. Activities for decommissioning would be similar to those for construction but on a more limited scale. Potential impacts on ambient air quality would be correspondingly less than those for construction activities. The area disturbed during decommissioning/reclamation could be exposed to wind erosion. Stabilizing disturbed soils would reduce these emissions. However, given that stabilization of certain soil types in dry climates is not fully effective, wind erosion from disturbed areas could continue after decommissioning/reclamation, particularly if highly erodible soils were disturbed. The potential for persistent wind erosion from disturbed soils needs to be addressed in site-specific assessments during the ROW application process to assess the severity of potential impacts.

5.2.1.2 Cumulative Impacts

Cumulative air quality impacts from criteria pollutants, including PM carried in fugitive dust emissions during construction of solar energy facilities, in conjunction with PM emissions from other past, current, and foreseeable activities in the planning area could occur locally and temporarily. For example, associated PM concentrations could temporarily exceed ambient air quality standards at construction site boundaries and possibly affect visibility in pristine areas such as national parks or other Class I areas. In addition, long-distance transport of fugitive dust (notably dark particles of dust and soot associated with utility-scale PV development) could contribute to snowmelt in affected mountain areas. Application of design features includes implementation of an extensive dust abatement plan that would substantially reduce the PM levels generated during construction. Portions of facilities that remain vegetation-free during operations could be a contributor to windblown fugitive dust, although design features requiring dust minimization would reduce this source.

Overall, air quality impacts associated with construction and operation emissions from PV solar energy facilities are expected to be small relative to the impacts associated with non-renewable (fossil fuel–fired) energy production and distribution.

There are also air quality benefits associated with solar energy development. If total solar energy development on BLM-administered lands reaches the RFDS level over the 20-year planning period and the energy generated displaces fossil fuel energy sources, more than 30,672 tons/yr of SO_2 and 90,305 tons/yr of NO_x emissions would be avoided by solar energy development, as provided in Appendix F, Table F.2.3-2. These amounts represent 38% and 46% of the 2021 annual emissions of SO_2 and NO_x, respectively, from the electric power system in the 11-state planning area.

While renewable energy development is expected to continue to increase, depending on national energy policies and trends in costs of development across the energy sectors, non-renewable energies like coal and natural gas may continue to represent a large proportion of the energy produced and consumed in the planning area (up to 64% in

2050, down from 77% in 2022; see Appendix J). Emissions of criteria air pollutants including PM from coal and natural gas sources are substantially higher than the emissions generated from PV solar energy facilities.

Portions of the planning area have well-known ongoing air quality problems, primarily southern California, and southern Nevada. Solar energy development in such regions may worsen air quality temporarily during construction when emissions of PM are occurring. However, to the extent that PV solar energy facilities located on BLM-administered lands are replacing energy production from fossil fuels, pollutants loads would be substantially reduced for combustion-related pollutants such as SO_2, and NO_x, thereby improving air quality.

5.2.1.3 Design Features and Additional Mitigation Measures

The BLM has identified design features that will be requirements for all utility-scale solar energy projects on BLM-administered lands subject to the ROD for this Programmatic EIS. The list of design features that have been identified to avoid, minimize, and/or compensate for potential impacts on air quality from solar energy development can be found in Appendix B.2.1.

In addition to the design features, the following mitigation measures may be useful in avoiding, minimizing, and/or mitigating some air quality impacts:

- Project developers should enforce posted speed limits (e.g., 10 mph [16 km/h]) within the construction site to minimize airborne fugitive dust.
- Project developers should consider surfacing access roads with aggregate that is hard enough that vehicles cannot crush it.
- Project developers should consider paving the main access road to the administration/operation and maintenance building and parking lots.
- Project developers should use compatible native vegetative plantings to limit dust generation from stockpiles that will be inactive for a relatively long period.

5.2.1.4 Comparison of Alternatives

5.2.1.4.1 No Action Alternative

Under the No Action Alternative, approximately 47.3 million acres of BLM-administered lands would be available for applications for solar energy development. Of the total lands available for application, 330,195 acres are located within existing priority areas, approximately 15.7 million acres are variance lands allocated in the 2012 Western Solar Plan for the six-state planning area, and approximately 31.6 million acres would be available for application within the five additional states considered in this Programmatic EIS, as these lands were not addressed in the 2012 Western Solar Plan.

Of the lands available for utility-scale solar ROW applications, under the RFDS the BLM estimates that approximately 700,000 acres (1.4%) of BLM-administered land will host utility-scale PV solar energy development over the next 20 years. Adverse air quality described in Section 5.2.1.1 that could occur from the construction and operation of PV solar energy facilities are mainly associated with PM emissions and are generally low under the No Action Alternative. However, decreased emissions of other criteria air pollutants may be substantial (see Section 5.2.1.2, Cumulative Impacts). Specifically, the SO_2 and NO_x emissions avoided if solar energy development on BLM-administered lands reaches the RFDS level and the energy generated displaces fossil fuel energy sources would be 30,672 tons/yr and 90,305 ton/year, respectively, as shown in Appendix F, Table F.2.3-2. The magnitude of benefits to air quality from this level of development would depend on the location of fossil fuel emissions displaced and their proximity to Federal Class I or other sensitive receptor locations.

In the six states addressed under the 2012 Western Solar Plan, the design features from that plan would mitigate air quality impacts. In the five new states, required mitigation measures for air quality impacts would be established at the project-specific level.

5.2.1.4.2 Action Alternatives

Alternative 1. Approximately 55 million acres of BLM-administered lands would be available for utility-scale solar ROW application.

Alternative 2. Approximately 36.2 million acres of BLM-administered lands would be available for utility-scale solar application.

Alternative 3. Approximately 22.2 million acres of BLM-administered lands would be available for utility-scale solar application.

Alternative 4. Approximately 11.2 million acres of BLM-administered lands would be available for utility-scale solar application.

Alternative 5. Approximately 8.4 million acres of BLM-administered lands would be available for utility-scale solar application.

The RFDS estimates that solar energy development would occur only on approximately 700,000 acres within BLM-administered lands available under Alternatives 1 through 5. Adverse air quality impacts described in Section 5.2.1 that could occur from the construction and operation of PV solar energy facilities under the Action Alternatives are mainly associated with PM emissions and are generally low. However, decreased emissions of other criteria air pollutants may be substantial (see Section 5.2.1.2, Cumulative Impacts).The PM emissions and reductions in air pollutant emissions under the Action Alternatives would be the same as under the No Action Alternative, assuming that the RFDS projected level of development occurs. However, the magnitude of adverse impacts and benefits on air quality would depend on the specific locations of solar energy development and proximity to Federal Class I or other specially designated areas, which are project-specific. Because lands available for application under Alternatives 3, 4 and 5 are restricted to areas close to existing or planned transmission and/or previously disturbed lands, those areas may be more distant from Federal Class I or other specially designated areas, and thus impacts may be reduced under these alternatives. Updated and more prescriptive design features may reduce the magnitude of adverse impacts on air quality in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

5.2.2 Climate

This section evaluates both negative and positive climate impacts associated with utility-scale solar energy development on BLM-administered lands. Negative impacts are associated with emissions of GHGs during all phases of project development. Most GHG emissions are associated with use of heavy equipment and large on-road vehicles powered by diesel during construction along with a small contribution from small on-road vehicles powered by gasoline throughout project operations. Positive impacts may occur if solar facility energy generation during operations replaces fossil fuel sources of energy, thus avoiding the GHG emissions from those fossil fuel sources.

5.2.2.1 Direct and Indirect Impacts

5.2.2.1.1 Site Characterization

A description of GHG emission sources during site characterization is presented in Section 5.2.1.1.1. Considering the level of activities, the potential impacts of these site characterization activities on climate would be negligible and far lower than those from construction activities.

5.2.2.1.2 Construction

A description of GHG emission sources during construction is presented in Section 5.2.1.1.2. In general, GHG emissions during construction are higher than emissions during other phases of a solar energy development project. However, GHG emissions during construction of solar energy facilities would be relatively small compared to industries with more intense activities (e.g., nuclear power plant construction), for which GHG emissions generally fall below the regulatory reporting threshold (discussed in Section 5.2.2.1.3).

5.2.2.1.3 Operations and Maintenance

A description of GHG emission sources during operations is presented in Section 5.2.1.1.3. Considering the low level of activities, the potential impacts of these site operation activities on climate would be negligible and far lower than those of construction activities.

The increase of GHG emissions, mostly CO_2, in the atmosphere over the industrial era is the result of human activities and human influence is the main driver of many changes observed across the atmosphere, ocean, cryosphere and biosphere (Arias et al. 2021). These changes (e.g., increases in global surface temperatures, more frequent heat waves and droughts, earlier snowmelt and increasing wildfires, extreme rainfalls and flooding, glacier melting and sea level rises) are linked to increases in GHG emissions, and some changes may be irreversible.

The EPA's Mandatory GHG Reporting Rule (74 FR 56260) requires reporting of annual GHG emissions for about 7,600 direct emitting facilities that account for about 50% of national GHG emissions. Additional GHGs are accounted for by about 1,000 fuel and industrial gas suppliers. In total, these data cover 85–90% of U.S. GHG emissions (EPA 2023g). The rule focuses on large emitters of GHGs, including power generation facilities, and other industrial entities. Facilities that emit GHGs from certain sources—such as the production of cement, aluminum, and lime—are required to comply with the rule regardless of emission rate. Other GHG sources must report only if the facility's GHG emissions exceed the reporting threshold of 25,000 metric tons (MT) of carbon dioxide equivalent (CO_2e). Solar energy facilities are expected to have small GHG emissions and would not be required to report under this rule.

A potential benefit from the operation of solar energy facilities would include the reduction of GHG emissions from a fossil fuel power plant that would otherwise be in operation to supply the same amount of electricity. As described above, energy markets are complex and new PV-generation is not expected to completely replace fossil fuel generation. But to the extent that increased PV-generation reduces fossil fuel generation, there would be an overall reduction in GHG emissions.

Composite emission factors are estimated on the basis of total annual power generation and associated GHG emissions for all types of fossil fuel power plants currently in operation in the 11-state planning area (see Table 5.2.2-1). CO_2 emissions represent the majority of these emissions. As shown in Table 5.2.2-1, based on the composite GHG emission factors from fossil fuel-fired generation, an estimated maximum of 620 kg (1,367 lb.) of CO_2e (CO_2, CH_4, and N_2O combined by applying GWP factors as discussed in Section 4.2.2.2) could be displaced per MWh of solar energy produced. These equivalency factors do not account for potential market substitution, so the actual GHG savings are expected to be less than the maximum.

Table 5.2.2-1. Composite Emission Factors for GHGs from Combustion-Related Power Generation in the 11-State Planning Area

Composite Emission Factor	kg/MWh[a]
CO_2	617
CH_4	0.048
N_2O	0.007
CO_2e	620

[a] Composite emission factors for 11-state planning area based on individual state composites weighted by the power generated in each state (EPA 2023j).

Operation of a hypothetical 750-MW PV facility with a capacity factor of 27.5% could result in avoidance of up to 0.46% of CO_2e emissions from electric power facilities and 0.10% of CO2e emissions from all source categories in the 11-state planning area (Table 5.2.2-2). In 2021, combustion-related power generation averaged over the 11 states was about 53% of the fuel mix (EPA 2023j). Fossil fuel power plants in Colorado (68%), Nevada (69%), New Mexico (64%), Utah (88%), and Wyoming (78%) account for more than 60% of each of these state's power generation, while non-combustion power plants (e.g., hydro, and/or renewable energy) in Idaho (67%), Oregon (63%), and Washington (81%) account for more than 60%. In California, the amount of electricity generation from fossil fuel power plants is comparable to that from non-combustion power plants. Reductions in GHG emissions would result from siting PV solar energy facilities in any of the 11 states.

Table 5.2.2-2. Potential GHG Emissions Avoided for Individual PV Solar Energy Facilities from Displacement of Combustion-Related Power Generation

Capacity	Annual Generation[a]	Emissions Displaced (MT CO_2e/yr)[b]
5–750[c] MW	12.1–1,807 GWh/yr	7,470–1,120,474
% of total emissions from 11 states	Electric power generation for 2021[d]	0.003–0.46
	All sources for 2020[e]	0.0007–0.10

[a] Used a composite capacity factor of 27.5%, averaged over 11-state planning area in 2021. Note that higher capacity factors than the composite capacity factor occur in some of the southwestern states (e.g., Arizona, California, or Nevada).

[b] See Table 5.2.2-1 for 11-state composite emission factors.

[c] See assumptions provided in Section 3.1-2. The range of facility capacities is based on the capacities of approved facilities on BLM-administered lands through 2022. The BLM has received ROW applications for larger facilities up to 4,000 MW; air quality impacts can be scaled on a per MWh basis.

[d] Data are taken from the EPA's *eGrid* database.

[e] See Table 4.2-2.

Source: EIA (2023b,c); EPA (2023j).

Overall, GHG emissions could be reduced if solar energy production replaces fossil fuel energy production over the next 20 years or more. Contributions of GHG emission reductions from electricity generation vary from state to state depending on the energy mix. For a hypothetical 750-MW PV facility using state-specific capacity factors (EIA 2023b,c), and emission factors (EPA 2023j), reduction of GHG emissions would range from up to 1.7% in California to up to 32% in Idaho if future fossil energy production were avoided by solar energy production (EPA 2023f) as provided in Appendix F, Table F.2.3-3. In 2020, GHG emissions from transportation accounted for about 41% of California's GHG emissions, while those from electricity generation accounted for about 9.4%. In contrast, in Idaho, GHG emissions from agriculture are the primary source (about 44%), while those from electricity generation accounted for only 5.2%.

Consistent with the CEQ guidance at 88 FR 1196 (White House 2023), evaluating GHG impacts from proposed PV projects should follow a rule of reason that allows agencies to determine, based on their expertise and experience, how to consider an environmental impact and prepare an analysis based on the available information.

The CEQ guidance also recommended that agencies provide additional context for GHG emissions, including through the use of the best available social cost of GHG (SC-GHG) estimates, to translate climate impacts into the more accessible metric of dollars, allow decision makers and the public to make comparisons, help evaluate the significance of an action's climate change impacts, and better understand the tradeoffs associated with an action and its alternatives (White House 2023).

Per CEQ guidance, Agencies also can provide accessible comparisons or equivalents to help the public and decision makers understand GHG emissions in more familiar terms, such as household emissions per year, annual average emissions from a certain number of cars on the road, or gallons of gasoline burned. The Greenhouse Gas Equivalencies Calculator allows conversion of emissions or energy data to the equivalent amount of CO_2 emissions associated with fuel use (EPA 2023k). Using the calculator, the total GHG emissions avoided if a 750-MW PV solar energy facility displaces a combustion-related power plant (about 1,120,474 MT CO_2e per year; Table 5.2.2-2) are equivalent to GHG emissions from 249,340 gasoline-powered passenger vehicles driven for 1 year; 2.8 natural gas–fired power plants operated for 1 year; or the energy use of 141,220 homes for 1 year.

For federal agencies, the best currently available estimates of the SC-GHG are the interim estimates of the social cost of carbon dioxide (SC-CO_2), the social cost of methane (SC-CH_4), and the social cost of nitrous oxide (SC-N_2O), developed by the Interagency Working Group on Social Costs of Greenhouse Gases (IWG). Select estimates are published in the Technical Support Document (IWG 2021), as presented in Appendix F, Figure F.2.3-1, and the complete set of annual estimates are available on the Office of Management and Budget's website.

The SC-GHGs associated with the maximum estimated emissions reduction due to the proposed PV facilities are in Table 5.2.2-3. These estimates represent the present value of future market and nonmarket costs associated with CO_2, CH_4, and N_2O emissions. Estimates are calculated based on IWG estimates of social cost per metric ton of emissions (assuming a 2025 emissions year) and the BLM's estimate of emissions generated by 750 MW of electricity from fossile fuel generation each year after fully built. Actual SC-GHG reduction depends on the acutal reduction in fossil fuel generation and is expected to be lower than the amounts in Table 5.2.2-3.

Table 5.2.2-3. Maximum SC-GHGs for a Hypothetical 750-MW PV Facility in 2025[a]

Average Value, 5% discount rate	Average Value, 3% discount rate	Average Value, 2.5% discount rate	95th Percentile Value, 3% discount rate
19.1	62.8	93.1	189.4

[a] Values provided in 2020 million$.

5.2.2.1.4 Transmission Lines and Roads

A description of GHG emission sources from transmission line and road construction is presented in Section 5.2.1.1.4. During this phase, use of heavy equipment would be substantial but still lower than that of solar energy facility construction activities. Thus, the potential impacts on climate from transmission lines and roads would generally be minor.

5.2.2.1.5 Decommissioning/Reclamation

Description of GHG emission sources during this phase is presented in Section 5.2.1.1.5. Activities for decommissioning would be similar to those for construction of solar energy facilities but on a more limited scale. Accordingly, potential impacts on climate from decommissioning activities would correspondingly less than those for construction activities and would be minor.

5.2.2.2 Cumulative Impacts

As discussed in Section 4.2.2, increasing atmospheric levels of GHGs (primarily CO_2) are resulting in global climate change (Arias et al. 2021; USGCRP 2018). Utility-scale PV solar energy development contributes relatively minor GHG emissions as a result of emissions from heavy equipment, primarily used during the construction phase; and vehicular emissions. The removal of vegetation from within the ROW of solar energy facilities would reduce the amount of carbon uptake by terrestrial vegetation, but only by a small amount (about 0.8% of the CO_2 emissions avoided by a solar energy facility compared to fossil fuel generation facilities; see Appendix F, Section F.2).

Like other renewables, solar PV generates low life cycle GHG emissions of about 43 gCO_2e/kWh, which include upstream, operational, and downstream processes (NREL 2021). For reference, natural gas- and coal- fired electricity release about 11 and 23 times, respectively, more life cycle GHGs. On a 1-year basis, a hypothetical 750-MW PV facility would generate life cycle GHG emissions of about 77,721 $MTCO_2e$, while it can displace about 1,120,474 $MTCO_2e$, which is 14 times more than life cycle emissions (see also Appendix I, Section I.4). If solar energy development on BLM-administered lands reaches the RFDS level and the energy generated displaces fossil fuel energy sources, more than 123 million MT CO_2e/yr could be displaced by solar energy development, which represents about 51% of the 2021 annual GHG emissions from the electric power system in the 11-state planning area (see Appendix F, Table F.2.3-4). Given that coal and natural gas may continue to be a large proportion of the energy produced and consumed in the planning area (64% in 2050, down from 77% in 2022; see Section Appendix J), contributions to cumulative GHG emissions within the planning area from PV solar energy facilities on BLM-administered lands would likely be small.

In the near term, solar facilities would tend to reduce emissions from facilities serving peak loads rather than emissions from baseline loads served by large fossil fuel plants. Emissions from future fossil fuel plants serving peak loads, typically natural gas–fired plants, would nevertheless be avoided. The addition of BES to PV solar energy facilities could allow additional avoidance of emissions from baseload fossil fuel plants in the long term.

Because GHG emissions are aggregated across the global atmosphere and cumulatively contribute to climate change, it is not possible to quantify the specific cumulative impact on global climate from GHG emissions avoided by PV solar energy generation on BLM-administered lands in conjunction with other past, current, and reasonably-foreseeable GHG-generating activities over the next 20 years or more. It is likely that that increased PV solar energy generation would cumulatively result in fewer GHG emissions by avoiding electricity generation from operating and new fossil fuel facilities, but the magnitude of reduction is uncertain.

The deployment of PV panels would alter the way that incoming energy is reflected back to the atmosphere or absorbed, stored, and reradiated, which would lower the albedo of the area encompassed by the facility. Lower albedo results in positive radiative forcing, i.e., warming. In addition, carbon storage capacity of plants and soils would be lost due to site clearing for PV panels. However, the reduction in climate change resulting from displacement of fossil fuel emissions by PV electricity generation would be far greater than the relatively small warming impacts caused by albedo effects and loss of carbon storage capacity, which are discussed in greater detail in Appendix F, Section F.2.

5.2.2.3 Design Features and Additional Mitigation Measures

The BLM has identified design features that will be requirements for all utility-scale solar energy projects on BLM-administered lands subject to the ROD for this Programmatic EIS. The list of design features that have been identified to avoid, minimize, and/or compensate for potential impacts on climate from solar energy development can be found in Appendix B.2.2. Note that the design features identified for mitigation of climate impacts are the same as those for air quality impacts that are focused on decreasing use of fossil fuel powered equipment or vehicles.

In addition to the design features, the following mitigation measures may be useful in avoiding, minimizing, and/or mitigating some climate impacts:

- Project developers should use zero-emission vehicles, such as battery electric vehicles or fuel cell electric vehicles, whenever practicable.
- Project developers should limit the idling time of equipment to no more than 5 minutes, unless idling must be maintained for proper operation (e.g., drilling, hoisting, and trenching).
- Project developers should use newer and cleaner equipment that meets more stringent emission controls.

5.2.2.4 Comparison of Alternatives

5.2.2.4.1 No Action Alternative

Because GHG emissions are aggregated across the global atmosphere and cumulatively contribute to climate change, the specific locations of GHG emissions within the lands available for application under the No Action Alternative do not affect climate impacts. Instead, the total level of solar energy development determines the GHG emissions caused and avoided. The climate benefits from emissions avoided if solar energy development on BLM-administered lands reaches the RFDS level and the energy generated displaces fossil fuel energy sources would be more than 123 million MT CO_2e/yr, which represents about 51% of the 2021 annual GHG emissions from the electric power system in the 11-state planning area.

In the six states addressed under the 2012 Western Solar Plan, the design features from that plan would mitigate climate impacts, for example by requiring that construction equipment meet emission standards. In the five new states, required mitigation measures for climate impacts would be established at the project-specific level.

5.2.2.4.2 Action Alternatives

Because GHG emissions are aggregated across the global atmosphere and cumulatively contribute to climate change, the specific locations of GHG emissions within the lands available for application under the Action Alternatives do not affect climate impacts. Instead, the total level of solar energy development determines the GHG emissions caused and avoided. The GHG emissions and the magnitude of climate impacts under the Action Alternatives would be the same as under the No Action Alternative, assuming that the RFDS projected level of development occurs. That is, the climate benefits from emissions avoided if solar energy development on BLM-administered lands reaches the RFDS level and the energy generated displaces fossil fuel energy sources would be more than 123 million MT CO_2e/yr, which represents about 51% of the 2021 annual GHG emissions from the electric power system in the 11-state planning area.

Updated and more prescriptive design features, including requirements to leave vegetative cover in place across large areas of solar sites, may reduce the magnitude of impacts in comparison with the No Action Alternative.

5.3 Cultural Resources

Solar energy facilities could produce diverse impacts on cultural resources in and around the areas where they are built. Impacts could occur during both facility construction and operations. The following subsections discuss the common impacts on cultural resources that could occur from solar energy development and potentially applicable design features and mitigation measures.

5.3.1 Direct and Indirect Impacts

Cultural resources, including those listed or eligible for listing on the NRHP, and those cultural resources not eligible for listing on the NRHP could be affected by, or discovered during utility-scale solar energy development. Cultural resources are nonrenewable and, once damaged or destroyed, are not recoverable. Therefore, if a cultural resource is damaged or destroyed during solar energy development, this particular cultural location, resource, or object would be irretrievable. Cultural resources can have different values for different groups. For example, for cultural resources that are significant for their scientific value, data recovery is one way in which some information can be salvaged should a cultural resource site be adversely affected by development activity. Certain contextual data would be invariably lost, but new cultural resources information would be made available to the scientific community, and the public. Cultural resources can also be valuable for their benefit to education, heritage tourism, or for traditional uses. These types of impacts are less easily mitigated; however, by initiating consultation with State Historical Preservation Offices (SHPOs), affected Tribes, and stakeholders early in the planning process, the impact may be lessened through project redesign, mitigation, or avoidance.

The potential for impacts on cultural resources from solar energy development, including ancillary facilities such as access roads and transmission lines, whether on or off BLM-administered lands, is directly related to the amount of land disturbance and the location of the project. Impacts on cultural resources outside of the disturbance footprint at a site or landscape level resulting from the erosion of disturbed land surfaces and from increased accessibility to possible cultural resource locations, are also relevant.

Potential modes of impacts on cultural resources include the following:

- Complete destruction of cultural resources could result from the clearing, grading, and excavation of the project area and from construction of facilities and associated infrastructure if they are located within the ROW of the project.
- Degradation and/or destruction of cultural resources could result from the alteration of topography, alteration of hydrologic patterns, removal of soils, erosion of soils, runoff into and sedimentation of adjacent areas, and contaminant spills if sites are located on or near the project area. Such degradation could occur both within the project ROW and in areas downslope or downstream. While the erosion of soils could negatively affect cultural resources downstream of the project area by potentially eroding materials and portions of downstream archaeological sites, the accumulation of sediment could serve to protect some downstream sites by increasing the amount of protective cover. Erosion can also destabilize historic structures. Agents of erosion and sedimentation include wind, water, downslope movements, and both human and wildlife activities (e.g., foot and vehicular traffic).
- Contaminants absorbed into deposits with cultural resource remains could affect the analytical potential of material present at the site and thus the ability to interpret site components.
- Increases in human access and subsequent disturbance (e.g., looting, vandalism, and trampling) of cultural resources could result from the establishment of corridors or facilities in otherwise intact and inaccessible areas. Increased human access (including off-highway vehicle use, OHV) could expose archaeological sites and historic structures and features to greater probability of impact from a variety of stressors. Access to historic properties or traditional cultural properties (TCPs) could also be impeded by solar development in some instances. In addition, sensitive cultural resources such as rock art can be exposed to impacts from dust and vibration caused by vehicular traffic and the use of heavy machinery.
- Visual and auditory degradation of settings associated with significant cultural resources could result from the presence of utility-scale solar energy development and associated land disturbances and ancillary facilities. This could affect cultural resources for which visual integrity and/or a quiet setting is a

component of sites' importance and significance, such as sacred sites and landscapes, historic structures, TCPs, trails, and landscapes.

5.3.2 Cumulative Impacts

Areas rich in cultural resources include individual properties (sites, structures, features, and TCPs) and districts listed on or eligible for listing on the NRHP, National Historic Landmarks, National Historic Trails, and prehistoric and historic sites possessing significant scientific, heritage, or educational values. Such cultural resources are subject to loss during construction of solar energy facilities and associated roads and transmission lines. In the course of project-level decision making and implementation, cultural resource surveys, evaluations, and any resolution of adverse impacts from a project on properties that have been listed or are eligible for listing on the NRHP must be conducted prior to construction of that project. Consultation with affected Indian Tribes regarding their knowledge of and/or concerns for cultural resources in a given project area must be conducted early and often throughout the project development process. In the event that cultural resources are unexpectedly encountered during construction activities, provisions should be in place to address the appropriate evaluation and treatment of such discoveries.

Impacts on cultural resources from other foreseeable development in the 11-state region could contribute to cumulative impacts. Other types of energy development, including oil and gas development as well as geothermal and wind energy development, would result in surface disturbance. Other land uses such as livestock grazing, mining, wild horse and burro (WH&B) management, and recreation including OHV use could also cause cumulative impacts on cultural resources. Under the RFDS, the BLM estimates that a total combined area of approximately 700,000 acres of BLM-administered lands and 600,000 acres of other lands (including private lands and state-owned lands) across the 11-state planning area will host utility-scale PV solar energy development over the next 20 years. Cumulative impacts on cultural resources from foreseeable development of PV solar energy facilities on BLM-administered lands in the 11-state region are expected, but for the most part, PV solar energy facilities could, and wherever possible would, be sited away from areas rich in cultural resources incorporating design features to minimize impacts.

5.3.3 Design Features and Additional Mitigation Measures

The BLM has identified design features that will be requirements for all utility-scale solar energy projects on BLM-administered lands subject to the ROD for this Programmatic EIS. The list of design features that have been identified to avoid, minimize, and/or compensate for potential impacts on cultural resources from solar energy development can be found in Appendix B.3.1.

In addition to the design features, the following mitigation measures may be useful in avoiding, minimizing, and/or mitigating some impacts on cultural resources:

- Where the BLM determines that a specific proposed solar energy project has the potential to adversely affect historic properties but those impacts cannot be determined prior to its approval, the BLM may elect to review a proposed solar energy project using an undertaking-specific Programmatic Agreement executed pursuant to the BLM National Programmatic Agreement (2012l) and 36 CFR 800.14, use the standard Section 106 consultation process identified in 36 CFR Part 800, or follow the procedures outlined in the 2012 Solar PA if the proposal is within a SEZ.

5.3.4 Comparison of Alternatives

5.3.4.1 No Action Alternative

NRHP-listed sites are currently excluded from solar energy development in the six states addressed under the 2012 Western Solar Plan, which provides an important initial mitigation of potential impacts on these cultural resources in these states. In the five states not evaluated in the 2012 Western Solar Plan, NRHP-listed sites could be available for solar energy development, unless the protection afforded by NRHP-designation or other restrictions would preclude it, so impacts on NRHP-listed sites are potentially greater under the No Action Alternative in these states.

The comparison of alternatives analysis looked at the number of known cultural resources, the number of NRHP-eligible sites, and the number of sites of unknown eligibility[3] within the areas available for application for each alternative and by state. Details of the analysis are presented in Appendix F, Section F.3. As expected, the number of known resources decreased as the area available for application decreased.

Under the No Action Alternative, the BLM-administered lands available for utility-scale solar ROW application (approximately 47.3 million acres) overlap with 67,926 NRHP-eligible and unknown eligibility sites (Table 5.3-1). Of the lands available for application, under the RFDS the BLM estimates that approximately 700,000 acres (1.4%) of BLM-administered lands will host utility-scale PV solar energy development over the next 20 years, allowing flexibility to avoid potentially eligible NRHP sites during project-specific evaluations. In the six states addressed under the 2012 Western Solar Plan, the design features from that plan would mitigate impacts on NRHP-eligible and unknown eligibility sites. In the five new states, required mitigation measures for impacts on NRHP-eligible sites would be established at the project-specific level.

[3] Sites categorized as undetermined or unknown are generally treated as eligible until investigation is complete.

Table 5.3-1. Count of Cultural Resources, NRHP-Eligible and Unknown Eligibility Sites Potentially Affected by Solar Energy Development on BLM-Administered Lands in the 11-State Planning Area[a]

11-State Planning Area	No Action	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
Total Known Sites	103,519	120,337	86,637	63,023	51,596	41,029
NRHP-eligible and Unknown/ undetermined Sites[c]	67,926	73,743	53,824	38,106	31,875	24,796
Not NRHP-eligible	35,593	46,594	32,813	24,917	19,721	16,233

Source: National Cultural Resources Information System (NCRIMS). Best available data are from 2020. Updated data are anticipated to be published in January 2024 and will be incorporated between draft and final EIS.

[a] Includes SEZs as amended, solar emphasis areas (BLM 2015), and the Dry Lake East DLA (BLM 2019a. These total priority area in each state have been updated to reflect changes implemented since 2012 (see Section 1.3).

5.3.4.2 Action Alternatives

NRHP-listed sites are excluded from solar energy development under each action alternative, which provides an important initial mitigation of potential impacts on these cultural resources. However, there are many NRHP-eligible and unknown eligibility sites that are not excluded. Potential impacts on such sites and methods to mitigate such impacts would be evaluated on a project specific basis.

For each action alternative, an analysis of the number of NRHP-eligible and unknown eligibility sites potentially impacted was conducted based on the overlap of sites with the public land available under the alternative (Table 5.3-1).

In general, the Action Alternatives would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based and other exclusion criteria, while making other BLM-administered lands available for application. Updated and more prescriptive design features applicable for all Action Alternatives may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 1. Approximately 55 million acres of BLM-administered lands would be available for utility-scale solar ROW application. The BLM-administered lands available for application would overlap with 73,743 NRHP-eligible and unknown eligibility sites. Of the action alternatives, Alternative 1 would potentially affect the greatest number of NRHP-eligible and unknown eligibility sites.

Of the lands available for application, under the RFDS the BLM estimates that approximately 700,000 acres (1.4%) of BLM-administered lands will host utility-scale PV solar energy development over the next 20 years, allowing flexibility to avoid NRHP-eligible and unknown eligibility sites during project-specific evaluations. Alternative 1 would make more lands available for application than under the No Action Alternative.

Alternative 2. Approximately 36.2 million acres of BLM-administered lands would be available for utility-scale solar ROW application. The BLM-administered lands available for application would overlap with 53,824 NRHP-eligible and unknown eligibility sites. Of the action alternatives, Alternative 2 would potentially affect the second highest number of NRHP-eligible and unknown eligibility sites. The RFDS estimates that solar energy development would occur only on approximately 700,000 acres, which is about 2% of the lands available for solar ROW application under Alternative 2.

Alternative 3. Approximately 22.2 million acres of BLM-administered lands would be available for utility-scale solar ROW application. The BLM-administered lands available for application would overlap with 38,106 NRHP-eligible and unknown eligibility sites. The RFDS estimates that solar energy development would occur only on approximately 700,000 acres, which is about 3% of the lands available for solar ROW application under Alternative 3.

Alternative 3 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a >10% slope exclusion. Alternative 3 would also limit development to areas that are less than 10 miles from existing or planned transmission lines of >100 kV, focusing development in areas that may be more likely to be economically feasible for development. Limiting development to areas that are less than 10 miles from existing and planned transmission lines would focus development in areas that may already be impacted by edge effects of transmission infrastructure, and thus potentially reduce impacts on cultural resources in comparison with Alternatives 1 and 2.

Alternative 4. Approximately 11 million acres of BLM-administered lands would be available for utility-scale solar ROW application. The BLM-administered lands available for application overlap with 31,875 NRHP-eligible and unknown eligibility sites. The RFDS estimates that solar energy development would occur on approximately 700,000 acres, which is about 6% of the lands available for solar ROW application under Alternative 4.

Alternative 4 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a >10% slope exclusions. Further, by limiting development to previously disturbed lands, Alternative 4 would potentially avoid higher-quality habitat that might be developed under Alternatives 1 through 3.

Alternative 5. Approximately 8.4 million acres of BLM-administered lands would be available for utility-scale solar ROW application. The BLM-administered lands available for application overlap with 24,796 NRHP-eligible and unknown eligibility sites. The RFDS estimates that solar energy development would occur only on approximately 700,000 acres, which is about 8% of the lands available for solar ROW application under Alternative 5.

Alternative 5 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a >10% slope exclusion. Alternative 5 would also combine the requirement that development be limited to areas that are less than 10 miles from existing or planned transmission lines of >100 kV (from Alternative 3) with the requirement to limit development to areas with previously disturbed lands (from Alternative 4), making it the alternative with the least lands available for solar ROW application.

Alternative 5 provides a focus on areas that may be more likely to be economically feasible for development because the lands available are near the transmission grid and limit the amount of new land disturbance.

5.4 Ecological Resources

Direct, indirect, cumulative impacts, mitigation measures, and comparison of alternatives for ecological resources are evaluated in four separate categories in the following subsections: Section 5.4.1 evaluates impacts on vegetation, Section 5.4.2 evaluates impacts on aquatic biota, Section 5.4.3 evaluates impacts on wildlife, and Section 5.4.4 evaluates impacts on SSS.

5.4.1 Vegetation

5.4.1.1 Direct and Indirect Impacts

Potential impacts on terrestrial and wetland plant communities and habitats from the development of utility-scale solar energy projects would include direct impacts from habitat loss and fragmentation, as well as a wide variety of indirect impacts (Table F.4.1.3-1). Impacts would be incurred during site characterization, initial site preparation, and construction phases, and continue throughout the operational life of the facility, typically extending over several decades. Plant communities and habitats affected by direct or indirect impacts from project activities could incur short- or long-term changes in species composition, abundance, and distribution. Some impacts may also continue after the decommissioning of a solar energy project.

Land areas available for solar energy development support a wide variety of plant communities and habitats. The evaluation of impacts on these resources from the construction, operation, and decommissioning of a solar energy facility is based on the Level III ecoregions within the 11-state planning area (EPA 2022b). Habitat types associated with the ecoregions occurring in these states are described in Appendix E. Figure F.4.1.3-1 shows the solar resources in relation to the ecoregions. The plant communities that could be affected by project development and the nature and magnitude of impacts that could occur would depend on the specific locations of the projects, as well as on the specific project design and the mitigation measures implemented to address impacts. These impacts would be considered in project-specific National Environmental Policy Act of 1969 (NEPA) analyses that would be conducted at the development phases of the projects.

Much of the land area used for solar energy facilities would be impacted throughout the life of the facility, either through direct clearing or intensive management. Facilities on BLM-administered lands may have nameplate capacities to 750 MW or higher (Section 3.1.2), with an estimated 4–7 acres required per MW. Storage may add an additional 1 acre/MW. For example, a 500-MW PV facility may be approximately 4,000 acres (16.2 km^2) in size. The impacts can be considered commensurate with the size of the facility with all mitigation being equal. In addition to the loss of existing habitat and fragmentation, the project site could be a continual source of particulates deposited on surrounding plant communities. Adjacent plant communities and pollinator habitat could be affected by increased runoff, altered hydrology, temperature gradients, sedimentation, reduced water quality, and erosion.

Plant communities and pollinator habitat outside of the areas directly affected by solar energy facilities could be indirectly affected by dust deposition from construction activities, increased surface water runoff, and related erosion or through the introduction of invasive species. Development of a dust abatement plan with extensive measures to limit dust generation during construction and operations is a design feature applicable under all alternatives. Similarly, multiple design features require the control of surface water runoff and erosion. The spread of invasive species would be addressed through integrated vegetation management as directed in Appendix B. With implementation of these measures, indirect cumulative impacts on vegetation are expected to be small.

5.4.1.1.2 Site Characterization

Direct impacts on plant communities during site characterization could occur from the operation of vehicles transporting equipment to off-road locations. Damage to plants, wetland soils, and biological soil crusts could result in long-term impacts and may require considerable periods of time for recovery to take place. Trampling from foot traffic would be expected to result in minor short-term impacts. The construction of access roads would eliminate vegetation within the roadway footprint and could result in indirect impacts on nearby areas from altered drainage patterns, runoff, sedimentation, and increases in non-native, invasive plant species that could spread into adjacent wildlands. Soil borings and the installation of meteorological towers and groundwater wells could directly affect plant communities, potentially including sensitive habitats, remnant vegetation associations, or rare natural communities. Impacts could result from soil disturbance, the removal of vegetation, burial by drill cuttings, or the impoundment of drilling fluids. Erosion of exposed soils or cuttings or releases of drilling fluids could affect downstream habitats, such as wetlands, by sedimentation or the introduction of contaminants.

5.4.1.1.3 Construction

Direct impacts would primarily include the destruction of habitat during any land clearing on the solar energy project site, as well as habitat losses resulting from the construction of access roads, underground electrical cables, water supply lines, and electric transmission lines. Site preparation activities may include the grading or excavation of soils to provide a level working area for equipment installation and, for some projects, excavation for equipment foundations. Land clearing on portions of the site may be required for construction of the solar array field, substation, maintenance buildings, and other necessary structures that may potentially result in considerable losses of habitat. Varying portions of land surface would be cleared during construction, depending on the amount of grading required, avoidance of sensitive areas, and the balance struck between (1) clearing vegetation for solar array placement and access and for fire safety and (2) maintaining low-growing vegetation for soil stabilization, stormwater control, and provision of habitat. Existing vegetation may be retained and mowed or crushed, rather than removed. Shrubs may be cut down to a few inches above their base, leaving their root structure intact (BLM 2018). Additional areas may be cleared for construction laydown and staging areas. Damage to plants may also result from equipment operating near land-clearing and construction areas.

Native vegetation communities present in project areas could be destroyed and may include rare communities, remnant vegetation associations, endemic species, riparian areas, non-jurisdictional wetlands (such as isolated wetlands), or jurisdictional wetlands. (See Appendix F, Section 4.1.3, for further discussion of jurisdictional and non-jurisdictional wetlands.) Federal and state regulations may require avoidance or mitigation of wetland impacts, and riparian policies of the BLM state offices would need to be followed. In general, the vast majority of lands subject to solar energy development occur within arid environments that often support unique species and ecosystems that are extremely sensitive to land disturbances and can take decades to recover.

While some land surfaces within the project site may be kept free of vegetation, the restoration of areas affected by temporary disturbances, such as construction staging areas or ROWs for electric transmission lines or water supply lines, includes the re-establishment of vegetation. Along with natural regeneration of native species that may occur, exposed soils in these areas would be seeded as directed under applicable BLM requirements. Further discussion on restoration of vegetation is in Appendix F, Section 4.1.3. The BLM is committed to the oversight of restoration efforts and ensuring that the Vegetation Management Plan for the site is followed.

Indirect impacts on terrestrial and wetland habitats on or off the project site could result from land clearing and exposed soil; soil compaction; and changes in topography, surface drainage, and infiltration characteristics. Indirect impacts could include the degradation of habitat from construction activities occurring in adjacent areas or, in the case of wetlands, activities occurring within the watershed or groundwater recharge area.

In addition to habitat removal, the operation of heavy equipment on the project site or ROWs may result in loss or destruction of existing vegetation and biological (microbiological) soil crusts and the compaction and disturbance of soils (Belnap and Herrick 2006). Soil aeration, infiltration rates, moisture content, and erosion rates could be affected. Biological soil crusts are important for soil stability, nutrient cycling, and water infiltration; their disturbance may affect the development of plant communities (Fleischner 1994; Belnap et al. 2001; Gelbard and Belnap 2003). All these factors could affect the rate or success of vegetation re-establishment.

Habitats adjacent to a solar energy facility or ROW may become fragmented or isolated as a result of construction and increased access to the site by the public and non-project personnel. Biodiversity may subsequently be reduced in fragmented or isolated habitats. The fragmentation of large, undisturbed habitats of high quality by facility or ROW construction would be considered a greater impact than construction through previously disturbed or fragmented habitat. Fragmentation would be most significant for projects that effectively eliminate habitat corridors and connectivity.

The prevention of the spread or introduction of noxious weeds and invasive plant species is a high priority to federal, state, and county agencies. Ground disturbance from construction may make vegetation communities more susceptible to infestations of noxious weeds or invasive plants. These species are most prevalent in areas of surface disturbance, such as roadsides, existing utility ROWs, and within the urban–wildland interface. For more information on noxious weeds and invasive species and their impacts, see Appendix F, Section 4.1.3.

The deposition of fugitive dust generated during clearing and grading activities and/or during the construction and use of access roads, or deposition that results from wind erosion of exposed soils, could reduce photosynthesis and productivity (Thompson et al. 1984; Hirano et al. 1995), increase water loss (Eveling and Bataille 1984) in plants near project areas, and result in injury to leaves. Considerable amounts of fugitive dust could be generated from the large areas of disturbed soil on a solar energy project site. Subsequently, if winds or precipitation do not remove deposits of fugitive dust, plant community composition could be altered, resulting in habitat degradation. In addition, pollinator species could be affected by fugitive dust, potentially reducing pollinator populations in the vicinity. Localized impacts on plant populations and communities could occur if seed production in some plant species is reduced.

Impacts on surface water and groundwater systems could affect terrestrial plant communities, wetlands, and riparian habitats, particularly in arid environments. Soil compaction and the removal of vegetation could reduce the infiltration of precipitation or snowmelt, resulting in increased runoff and subsequent erosion and sedimentation. For more details on how changes in hydrology affect plant communities, see Appendix F, Section 3.1.4. Sedimentation could degrade wetland and riparian plant communities. Impacts may include mortality or reduced growth of plants, altered species composition of wetland or riparian communities, reduced biodiversity or, in areas of heavy sediment accumulation, a reduction in the extent of wetland or riparian habitat.

Many native wetland species that are indicative of high-quality habitats are sensitive to disturbance, and they may be displaced by species more tolerant of disturbance or by invasive non-native species, thereby reducing biodiversity. Disturbance-tolerant species may become dominant in communities affected by these changes in hydrology and water quality. Increased sedimentation, turbidity, or other changes in water quality may provide conditions conducive to the establishment of invasive species.

Direct impacts on plant communities and habitats would be expected to occur along the ROWs for access roads, water pipelines, and transmission lines. Vegetation would be cleared for roadway, pipeline, or transmission tower construction. Riparian habitats or wetlands may be affected by ROWs that cross streams or other water bodies. Areas along ROWs that would be temporarily affected by construction activities would be restored in the same manner as other temporarily disturbed project areas. Tree removal from wetlands or riparian areas along ROWs may result in indirect impacts, such as reductions in soil moisture, erosion of exposed substrates, increases in water temperatures, or sedimentation. Removal of trees within or along forest or woodland areas would potentially result in an indirect disturbance to forest or woodland interior areas through changes in light and moisture conditions. The plant communities that become established on any area disturbed during ROW construction would depend on the restoration practices implemented, including the species selected, the species present in adjacent habitats, the degree of disturbance to vegetation and substrates, and the vegetation management practices selected for implementation.

5.4.1.1.4 Operations and Maintenance

Following construction, if the site was not completely cleared, vegetation cover types would recover at varying rates, depending on the type of species and the level of disturbance. It is anticipated that ungraded areas would recover to pre-disturbance conditions sooner than areas that were graded, because the plant root structures would not be affected. In ungraded areas where only the top portion of the plant was removed during construction, herbaceous-dominated plant communities such as grasslands would begin to grow back immediately following construction. Grasslands removed as part of grading would require a minimum of 3 to 5 years to establish adequate ground cover to minimize erosion (BLM 2018).

Impacts on plant communities and habitats during facility operations could include the continued effects of fugitive dust, effects from long-term changes in surface water or groundwater hydrology, effects of hazardous material spills, and the continued spread of non-native invasive plant species that can result in and perpetuate altered fire regimes. These impacts can lead to further losses of native plant communities in the area surrounding a project site. Any exposed soil or unpaved roads would provide a continual source of fugitive dust throughout the life of the facility, resulting in the long-term deposition of particulates onto plants in the vicinity. Such deposition, if winds or precipitation do not remove deposits of fugitive dust, could lead to long-term changes in plant community composition and productivity in the vicinity of a solar energy facility. Impacts on surface water quality from deposition of atmospheric dust from wind erosion of a solar energy facility could degrade terrestrial, wetland, and riparian habitats.

Potential indirect impacts on vegetation during operations of a PV facility would include potential changes to the vegetation community with the formation of microclimates under the solar arrays. This includes a lack of precipitation reaching the soil and shading under the solar arrays, however a reduction in solar radiation under the panels can lead to lower temperatures and higher soil moisture (Graham 2021). Plants that are more shade-tolerant may increase, while plants that require more sun may decrease. However, this indirect impact can be expected to be minor due to the spacing of the modules and the daytime movement of the modules (BLM 2018). The delay in bloom time of native plants due to shading underneath solar arrays may benefit late season pollinators (Graham 2021).

Groundwater use for facility operation may result in the alteration of groundwater flow in project areas, which may affect wetlands and riparian habitats that directly receive groundwater discharge, such as at springs or seeps (Patten et al. 2008). Streamflows that are supported by groundwater discharge could be reduced in the vicinity of the project, resulting in impacts on associated wetlands and riparian habitats, even those at considerable distances from a solar energy facility. Groundwater withdrawals in alluvial or basin-fill aquifers may cause water level declines that result in reduced discharges to wetlands or riparian communities, resulting in their reduction or elimination. Plant communities could be degraded by changes in community composition or through surface subsidence.

Water withdrawals from surface water sources, such as rivers and streams, could result in considerable reductions in streamflows and in water quality downstream. Reduced flows and water quality may reduce the extent or distribution of wetlands and riparian areas along these water bodies or degrade these plant communities.

Increased runoff from impervious or compacted surfaces can increase the degree of fluctuation of water surface elevations in relation to precipitation events in wetlands within the watershed, causing more rapid increases in water surface elevations during and immediately following storm events, as well as more rapid reductions in water levels between precipitation events. Such changes may result in greater extremes of high and low water levels, including the reduction of stream base flows and increases in flood flows. Wetland types typically supported by groundwater flows may be greatly affected by increases in surface water inflows or altered surface drainage patterns.

Changes in streamflows as a result of altered surface water drainage patterns, such as from the elimination of ephemeral drainages or grading and land contouring, could also affect wetlands and riparian communities along affected streams. Streamflows may be increased or reduced by the alteration of land surfaces. Plant communities and habitats could be adversely affected by changes in water quality or availability, resulting in plant mortality or reduced growth, with subsequent changes in community composition and declines in habitat quality. Increased streamflows as a result of altered surface drainage patterns can result in erosion, sedimentation, and increased salinities in surface water. Moderate sedimentation may reduce photosynthesis in (and therefore the productivity of) submerged plants. Heavy sedimentation may cover vegetation, resulting in reduced growth or mortality. Other impacts of sedimentation can include the displacement of sensitive species by more tolerant species, which may occur in high-quality, undisturbed wetlands. Wetlands and riparian areas could be adversely affected by decreased water quality and increased sedimentation, resulting in potential losses of or reductions in the extent of these habitats or in habitat degradation along affected streams.

Some facilities would store and use hazardous chemicals, oils, or other fluids. Accidental spills of hazardous materials would adversely affect plant communities. Direct contact with contaminants could result in the mortality of plants or the degradation of habitats. Contaminants could affect the quality of shallow groundwater and indirectly affect terrestrial plants whose root systems reach groundwater sources, such as phreatophytic plants. If shallow groundwater becomes contaminated, wetland and riparian communities supported by groundwater discharge could be adversely affected, resulting in habitat degradation.

Required weed abatement plans pose a risk to native vegetation. Several terrestrial herbicides are nonselective and could adversely affect non-target vegetation. Accidental spills and herbicide drift from treatment areas could be particularly damaging to nontarget vegetation (BLM 2021a).

5.4.1.1.5 Decommissioning/Reclamation

The decommissioning of solar energy facilities would also result in impacts on terrestrial and wetland plant communities. Decommissioning activities would likely include the dismantling and removal of all aboveground structures as well as some underground structures, such as underground electrical cables and water pipelines. Some buried pipelines may potentially be purged, cleaned, and left in place. The types of impacts resulting from decommissioning would be similar to those associated with facility construction. Decommissioning would result in soil disturbance, potentially including the regrading of some project areas. Ground disturbance would also occur in temporary work areas and storage areas. Vegetation would be removed or damaged in areas of disturbed soils, and these areas would require the re-establishment of plant communities. Excavation activities could occur in wetlands, and wetlands could be temporarily drained during the removal of some structures. Decommissioning activities would generally affect areas previously disturbed by initial facility construction.

Indirect impacts associated with decommissioning activities could include erosion, sedimentation, soil compaction, changes to surface water or groundwater hydrology, establishment of invasive species, deposition of airborne dust, and potential spills of hazardous materials. However, impacts of facility operations, such as water withdrawals from groundwater or surface water sources, and the impacts of ROW management would decrease following decommissioning. Public access to some areas may decline with the cessation of ROW management in woodlands or forested areas. Plant communities may be difficult to restore following decommissioning. See Appendix F, Section 4.1.3 for more details regarding restoration. In some locations, permanent differences between restored plant communities and nearby undisturbed areas would likely remain. Restoration would focus on the establishment of native plant communities similar to those present in the vicinity of the project site, and restoration efforts would be required to meet success criteria developed in coordination with the BLM.

5.4.1.1.6 Transmission Lines and Roads

A summary of impacts from transmission lines and roads is provided in Appendix F, Section 4.1.3.

5.4.1.2 Cumulative Impacts

Under the RFDS, the BLM estimates that a total combined area of approximately 700,000 acres of BLM-administered lands and 600,000 acres of other lands (including private lands and state-owned lands) across the 11-state planning area will host utility-scale PV solar energy development over the next 20 years. Under the new design features to be implemented through this Solar Programmatic EIS, there are multiple protections to avoid, minimize, and mitigate direct and indirect impacts on vegetation. For example, vegetation in the solar field areas would be left in place during the construction of PV solar energy facilities, which would reduce impacts on vegetation. However, some vegetation would still be damaged or destroyed during construction.

Some solar energy development will occur in arid or semiarid regions where restoration of vegetation is difficult and where the introduction of invasive species is a significant concern. Development of an integrated vegetation management plan is a required design feature that would require long-term control of invasive species through several means, including monitoring, seeding, or planting of desirable species, use of certified weed-free seed and mulching, treating infestations, and integrated pest management.

The main cover types that would be affected are typically abundant in the planning area, so impacts on these plant communities would not be large. A number of minor species are associated with rare or limited habitats, such as dunes, woodland, or riparian areas in desert regions. However, design features require coordination with appropriate federal and state agencies to identify these habitats and then avoid and minimize impacts on these vegetation habitats. In addition, the design features require revegetating the site with native plants to the maximum extent practicable. While solar energy facilities would avoid wash areas and wetlands to the extent practicable, some sensitive areas could still be affected by the facilities or by access roads, transmission lines, or pipelines that traverse them.

Cumulative direct impacts on plant communities from foreseeable development in the 11-state region could be moderate for some sensitive species. Because of the large land areas disturbed and the presence of sensitive communities, solar energy facilities could be a significant contributor to such impacts. Other types of energy development (including oil and gas development, geothermal and wind energy development), and other land uses (such as livestock grazing, mining, WH&B HMAs, and recreational opportunities including OHV use) could also cause additional cumulative impacts on vegetation. Mitigation measures, including avoidance, could protect most sensitive plant communities. Cumulative impacts on primary cover species would be small due to their abundance in the region and the relatively small portion of total lands required under the RFDS.

5.4.1.3 Design Features and Additional Mitigation Measures

The BLM has identified design features that will be requirements for all utility-scale solar energy projects on BLM-administered lands subject to the ROD for this Programmatic EIS. The list of design features that have been identified to avoid,

minimize, and/or compensate for potential impacts on vegetation from solar energy development can be found in Appendix B.4.1.

In addition to the design features, the following mitigation measures may be useful in avoiding, minimizing, and/or mitigating some impacts on vegetation (and other ecological) resources:

- Project developers shall, to the maximum extent practicable, site projects close to energy load centers, urban areas, and major transportation infrastructure to minimize large-scale impacts and fragmentation of open spaces.
- Project developers shall, to the maximum extent practicable, site projects on previously disturbed lands, brownfields, retired agricultural lands, and other disturbed areas instead of undisturbed, natural habitats to avoid and minimize impacts on remote, undisturbed lands.
- To the maximum extent practicable, project developers should avoid state-identified priority or critical habitats.

5.4.1.4 Comparison of Alternatives

5.4.1.4.1 No Action Alternative

Under the No Action Alternative, less than 1% of all of the ecoregions combined would be impacted by development in the existing priority areas. The ecoregions with the greatest percentages of lands allocated as variance lands in the 2012 Western Solar Plan for the six-state planning area are the Northern Basin and Range and the Chihuahuan Deserts at 31% and 21% respectively. Of the open available lands, under the RFDS the BLM estimates that approximately 700,000 acres (1.4%) of BLM-administered land will host utility-scale PV solar energy development over the next 20 years. In the six states addressed under the 2012 Western Solar Plan, the design features from that plan would mitigate vegetation impacts. In the five new states, required mitigation measures for vegetation impacts would be established at the project-specific level.

5.4.1.4.2 Action Alternatives

Alternative 1. Approximately 55 million acres of BLM-administered lands would be available for utility-scale solar ROW application. While the primary ecoregions within the alternative area include the Central Basin and Range and Chihuahuan Desert (31% and 21% of the lands available for application, respectively; Table F.4.1.3-2), solar energy development is expected to occur on approximately 700,000 acres (the RFDS value), which is about 1% of the land available for solar ROW application under Alternative 1. Plant communities including the predominant shrub and shrub/grass communities of the Central Basin and Range ecoregion, and the predominant arid grassland and shrubland communities of the Chihuahuan Deserts ecoregion would be affected by solar energy development through reduction of acreage and damage. The ecoregions with the greatest percentages of lands included as available for application under this alternative are the Central Basin and Range (43%), the Wyoming Basin (9%), and the Colorado Plateaus (7%; Table F.4.1.3-3).

Alternative 1 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria while making all other lands available for application. The elimination of the slope exclusion could result in additional impacts for some plant species indigenous to higher sloped areas in comparison to the No Action alternative.

Updated and more prescriptive design features (e.g., requirement to leave vegetation within solar arrays in place, prevent establishment and spread of invasive species, and focusing revegetation efforts on the establishment of native plant communities) may reduce the magnitude of impacts as compared to the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 2. Approximately 36.2 million acres of BLM-administered lands would be available for utility-scale solar ROW application. While the primary ecoregions within the planning area include the Central Basin and Range and Chihuahuan Desert (21% and 18% of the lands available for application, respectively; Table F.4.1.3-2), solar energy development is expected to occur on approximately 700,000 acres, which is about 2% of the lands available for solar ROW application under Alternative 2. Plant communities including the predominant shrub and shrub/grass communities of the Central Basin and Range ecoregion, and the predominant arid grassland and shrubland communities of the Chihuahuan Deserts ecoregion would be affected by solar energy development through reduction of acreage and damage. The ecoregions with the greatest percentages of lands included as available under this alternative are the Central Basin and Range (46%), the Wyoming Basin (10%), and the Chihuahuan Desert (9%; Table F.4.1.3-3).

Alternative 2 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria. The 10% slope exclusion would further limit some impacts on vegetation in comparison to Alternative 1 by excluding habitat of some plant species indigenous to these higher sloped areas. Updated and more prescriptive design features (e.g., requirement to leave vegetation within solar arrays in place, prevent establishment and spread of invasive species, and focusing revegetation efforts on the establishment of native plant communities) may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 3. Approximately 22.2 million acres of BLM-administered lands would be available for utility-scale solar ROW application. While the primary ecoregions within the planning area include the Chihuahuan Desert and Central Basin and Range (12% and 1% of the lands available for application, respectively; Table F.4.1.3-2), solar energy development is expected to occur on approximately 700,000 acres, which is about 3% of the lands available for solar ROW application under Alternative 3. Plant communities including the predominant arid grassland and shrubland communities of the Chihuahuan Deserts ecoregion and the predominant shrub and shrub/grass communities of the Central Basin and Range ecoregion would be affected by solar energy development through reduction of acreage and damage. The ecoregions with the greatest percentages of lands included as available under this alternative are the Central Basin and Range (40%), the Wyoming Basin (12%), and the Chihuahuan Deserts (10%; Table F.4.1.3-3).

Alternative 3 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a 10% slope exclusion. Alternative 3 would also limit development to areas that are less than 10 miles from existing and planned transmission lines of >100 kV, focusing development in areas that may be more likely to be economically feasible for development. Keeping development in areas that are less than 10 miles from existing and planned transmission lines would limit development to vegetation habitat that may already be impacted by edge effects of transmission infrastructure, and thus potentially reduce impacts in comparison with Alternatives 1 and 2.

Updated and more prescriptive design features (e.g., requirement to leave vegetation within solar arrays in place, prevent establishment and spread of invasive species, and focusing revegetation efforts on the establishment of native plant communities) may also reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 4. Approximately 11.2 million acres of BLM-administered lands would be available for utility-scale solar ROW application. While the primary ecoregions within the planning area include the Chihuahuan Desert and Snake River Plain (7% and 6% of the lands available for application, respectively; Table F.4.1.3-2), solar energy development is expected to occur on approximately 700,000 acres, which is about 6% of the lands available for solar ROW application under Alternative 4. Plant communities including the predominant arid grassland and shrubland communities of the Chihuahuan Deserts ecoregion and the predominant sagebrush-grassland communities of the Snake River Plain ecoregion would be affected by solar energy development through reduction of acreage and damage. The ecoregions with the greatest percentages of lands included as available under this alternative are the Central Basin and Range (31%), the Wyoming Basin (14%), and the Chihuahuan Deserts (12%; Table F.4.1.3-3).

Alternative 4 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria, and a 10% slope exclusion. Further, by limiting development to previously disturbed lands, Alternative 4 would minimize disturbance to lands with native vegetation that might be developed under Alternatives 1 through 3 . Updated and more prescriptive design features (e.g., requirement to leave vegetation within solar arrays in place, prevent establishment and spread of invasive species, and focusing revegetation efforts on the establishment of native plant communities) may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 5. Approximately 8.4 million acres of BLM-administered lands would be available for utility-scale solar ROW application. While the primary ecoregions within the planning area include the Chihuahuan Desert and Snake River Plain (each contain 5% of the lands available for application; Table F.4.1.3-2), solar energy development is expected to occur on approximately 700,000 acres, which is about 8% of the lands available for solar ROW application under Alternative 5. Plant communities including the predominant arid grassland and shrubland communities of the Chihuahuan Deserts ecoregion and the predominant sagebrush-grassland communities of the Snake River Plain ecoregion would be affected by solar energy development through reduction of acreage and damage. The ecoregions with the greatest percentages of lands included as available for application under this alternative are the Central Basin and Range (29%), the Wyoming Basin (15%), and the Chihuahuan Deserts (12%; Table F.4.1.3-3).

Alternative 5 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria, and a 10% slope exclusion. Alternative 5 would also combine the requirement that development be limited to areas that are less than 10 miles from existing or planned transmission lines of >100 kV (from Alternative 3) with the requirement to limit development to previously disturbed lands (from Alternative 4), making it the alternative with the least lands available for solar ROW application.

Alternative 5 provides a focus on areas that may be more likely to be economically feasible for development because the lands available are near the transmission grid and limit the amount of new land disturbance. The total reduction of land available in Alternative 5 as well as developing on previously disturbed lands would likely result in fewer impacts on native vegetation, however those impacts vary by ecoregions. Re-establishment of vegetation in the Central Basin and Range and the Chihuahuan Deserts Ecoregions, where the greatest percentages of land available for development occur under Alternative 5, may take decades.

Updated and more prescriptive design features (e.g., requirement to leave vegetation within solar arrays in place, prevent establishment and spread of invasive species, and focusing revegetation efforts on the establishment of native plant communities) may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

5.4.2 Aquatic Biota

5.4.2.1 Direct and Indirect Impacts

Utility-scale solar energy facilities that would be constructed and operated have the potential to affect aquatic biota (e.g., fish, amphibians, reptiles, birds, insects) in aquatic, wetland, and riparian habitats. The following discussion provides a brief overview of the potential impacts on aquatic ecosystems that could occur from site characterization, construction, operation, and decommissioning of a solar energy project. Similar impacts could occur during development and operation of transmission lines required to connect solar energy projects to the grid (see Section 5.4.2.1.5). See Appendix F.4.2 for a more in-depth look at potential impacts on aquatic biota and habitats from solar energy development. The use of design features (see Appendix B) would avoid or minimize impacts on aquatic species and their habitats. Specifics regarding application of design features for individual solar energy projects would be established through coordination with federal and state agencies and other stakeholders. Potential impacts on aquatic ecosystems during different phases of solar energy facility development are discussed below and summarized in Table 5.4.2-1.

5.4.2.1.1 Site Characterization

Typical activities associated with site characterization are summarized in Section 3.2.1. Some site characterization activities would assist developers in designing a specific project to avoid or minimize impacts on aquatic resources during future phases of the project. Potential impacts on aquatic habitats and aquatic biota from site characterization activities would primarily be associated with ground disturbance, because it increases soil erosion that can increase sedimentation and turbidity in downgradient surface water habitats, and because it can promote formation of gullies or down-cutting of water pathways that can lead to impacts on riparian and wetland habitats. As described in Section 3.2.1, many of the site characterization activities would involve minimal or no site disturbance. Ground-disturbance activities such as installation of meteorological towers, installation of groundwater sampling wells, would generally affect only small areas including the footprint of installed structures or equipment, the area disturbed by vehicles or other equipment needed for the installation and, in some cases, the development of minimum-specification access roads needed to reach the installation or sampling sites. It is anticipated that characterization facilities (e.g., meteorological towers, drill rigs, and temporary impoundments for drilling fluids or cutting) and most of the associated characterization activities would be located in upland areas and not directly within aquatic habitats. In such cases, direct impacts on aquatic habitats and biota would be minimal. Because the amount of ground disturbance would be small, the resulting impacts of erosion and sedimentation on aquatic habitats and biota from these impacting factors should also be small.

Other than discrete water sampling of groundwater and surface water, no water depletions would be expected during the characterization phase of a project and aquatic habitats would not be significantly affected. If drilling activities were required as part of site characterization, accidental releases of drilling wastes could affect downstream habitats because of sedimentation or the introduction of contaminants during storm runoff events.

Table 5.4.2-1. Potential Impacts on Aquatic Resources Associated with Utility-Scale Solar Energy Facilities, Including Associated Access Roads and Transmission Line Corridors

Impacting Factor	Project Phase	Potential Consequence	Expected Impact No Mitigation[ab]	Ability to Avoid, Minimize, or Mitigate Impacts[c]
Individual Impacting Factor[d]				
Alteration of topography and drainage patterns	Construction, operations	Changes in water temperature; change in distribution and structure of aquatic, wetland, and riparian habitat and communities; erosion; changes in groundwater recharge.	Moderate	Can be avoided or minimized by avoiding riparian habitats, limiting alteration of existing drainage patterns during site development, and using appropriate stormwater management strategies. Vegetation restoration would be required for any clearing of riparian areas.
Human presence and activity	Site characterization, construction, operations, decommissioning	Ground disturbance from vehicles and foot traffic; behavioral avoidance of areas by aquatic birds; habitat degradation; non-native species introductions.	Small	Can be mitigated during site characterization and construction by timing activities to avoid sensitive periods and locations. Difficult to mitigate impacts during operations. Decontaminating equipment would reduce the risk of non-native species introductions.
Blockage of dispersal and movement	Construction, operations	Genetic isolation; loss of access to important habitats; change in community structure; reduction in carrying capacity.	Small	Can be mitigated by restricting project size, avoiding water depletions and construction activities that would reduce connectivity among aquatic habitats.
Erosion	Construction operations, decommissioning	Sedimentation of adjacent aquatic systems; loss of productivity; change in communities; physiological stress.	Moderate	Easily avoided or minimized with standard erosion control practices.
Fugitive dust	Site characterization, construction, operations, decommissioning	Increase in turbidity and sedimentation in aquatic habitat; decrease in photosynthesis; change in community structure; physiological stress.	Small	Can be avoided or minimized by retaining vegetative cover, soil covers, or implementing dust control techniques (e.g., watering excavation areas).
Groundwater withdrawal	Construction, operations	Change in hydrologic regime; reduction in productivity and aquatic habitat at the surface.	Moderate	Can be avoided or minimized by using alternate water sources (e.g., trucking in water) and reducing water consumption requirements.

Impacting Factor	Project Phase	Potential Consequence	Expected Impact No Mitigation[a,b]	Ability to Avoid, Minimize, or Mitigate Impacts[c]
Individual Impacting Factor[d] (Cont.)				
Habitat fragmentation	Construction, operations	Genetic isolation; loss of access to important habitats; reduction in carrying capacity; change in community structure.	Large	Avoid and minimize disruption of intact communities especially by linear features such as transmission lines and roads. Minimize fragmentation of aquatic stream networks, including intermittent washes. Avoid and minimize activities and placement of structures in sensitive or unique aquatic habitats.
Increased human access	Construction, operations	Habitat degradation; fishing pressure.	Small	Can be mitigated by reducing the number of new transmission lines and roads in important habitats.
Oil and contaminant spills	Site characterization, construction, operations, decommissioning	Mortality; physiological stress; reproductive impairment; reduction in carrying capacity.	Moderate	Can be mitigated using project mitigation measures and spill prevention and response planning.
Restoration of topography and drainage patterns	Decommissioning	Impacts initially adverse; some degree of restoration to pre-construction conditions.	Moderate	Mostly beneficial; adverse impacts can be mitigated using standard erosion and runoff control measures.
Restoration of topsoil and native vegetation	Decommissioning	Reduced erosion and fugitive dust; increased productivity.	Moderate	Mostly beneficial; adverse impacts can be mitigated using standard erosion and runoff control measures.
Vegetation clearing and maintenance	Construction, operations	Change in water temperature; increased sedimentation from erosion and fugitive dust; changes in productivity and diversity; reduction in carrying capacity; herbicide runoff into aquatic habitats; acute and chronic toxicological impacts.	Large	Difficult to mitigate; most project areas are likely to require some clearing, although design features require avoidance of complete clearing under panels. Can be mitigated by managing for low-maintenance vegetation (e.g., native shrubs, grasses, and forbs), invasive species control, minimizing the use of herbicides near sensitive habitats (e.g., aquatic and wetland habitats), and using only approved herbicides consistent with safe application guidelines. Restoration of a vegetative cover consistent with the intended land use would reduce some impacts.

Impacting Factor	Project Phase	Potential Consequence	Expected Impact No Mitigation[ab]	Ability to Avoid, Minimize, or Mitigate Impacts[c]
Individual Impacting Factor[d] (Cont.)				
Vehicle traffic	Site characterization, construction, operations, decommissioning	Direct mortality of individuals through crushing; increased fugitive dust emissions.	Moderate	Can be mitigated using worker education programs, signage, and traffic restrictions.

[a] Relative impact magnitude categories were based on professional judgment using CEQ regulations for implementing NEPA by defining significance of impacts based on context and intensity. Similar impact magnitude categories and definitions were used in the BLM's NEPA Handbook (BLM 2008a) and Special Status Species Management Manual (BLM 2008b). Impact categories were as follows: (1) none—no impact would occur; (2) small—impacts are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. (e.g., <1% of the population or its habitat would be lost in the project area); (3) moderate—impacts are sufficient to alter noticeably but not to destabilize important attributes of the resource (e.g., >1% but <10% of the population or its habitat would be lost in the project area); and (4) large—impacts are clearly noticeable and are sufficient to destabilize important attributes of the resource (e.g., >10% of a population or its habitat would be lost in the project area). Assigned impact magnitudes assume no mitigation. Actual magnitudes of impacts on aquatic habitat and biota would depend on the location of projects, project-specific design, application of mitigation measures (including avoidance, minimization, and compensation), and the ecological condition of aquatic habitat and biota in project areas.

[b] Impacts on listed species are generally assessed at the individual scale instead of population scale and may be absent (no impact), insignificant and/or discountable (not likely to adversely affect), or adverse. Consequently, impacts on listed species could be different than the impacts identified to aquatic habitats and biota identified in this table. Detailed impacts analysis and determinations for listed species would be provided in project-specific Biological Assessments during ESA section 7 consultation.[c] Actual ability to mitigate impacts will depend on site-specific conditions and the species present in the project area. Design features for ecological resources are presented in Appendix B.

[d] Impacting factors are presented in alphabetical order.

If vehicles are driven through aquatic habitats or if workers walk through those habitats, some aquatic biota could be crushed and killed. Vehicular traffic can result in rutting and accumulation of cobbles in some stream crossings, which can interfere with fish passage in streams during periods of low flows. If such changes prevent fish and other aquatic species from leaving stream areas that periodically dry out and entering portions of streams that contain adequate water, mortality of trapped individuals would be expected. The significance of such impacts would depend on the types of aquatic communities present, with greater impacts anticipated in regionally unique habitats that support rare or endemic species. Such impacts can be avoided or minimized by constructing temporary or permanent bridges for vehicles or personnel.

5.4.2.1.2 Construction

Impacts on aquatic resources from the construction of utility-scale solar energy projects and associated transmission facilities could result from (1) direct disturbance of aquatic habitats within the footprint of construction or operation activities, (2) sedimentation of nearby aquatic habitats as a consequence of soil erosion from construction areas, and (3) changes in water quantity or water quality as a result of grading that affects surface runoff patterns, depletions or discharges of water into nearby aquatic habitats, or releases of chemical contaminants into nearby aquatic systems.

As described in Section 5.4.2.1.1, vehicles or machinery used in aquatic habitats and worker foot traffic through aquatic habitats could crush and kill aquatic organisms; such impacts can be avoided or minimized by constructing temporary or permanent bridges for vehicles or personnel. Draining and filling of aquatic habitats within the construction footprint for the solar energy facility or within associated transmission corridors would result in direct loss of any aquatic habitats or organisms within the construction footprint. Such direct impacts on aquatic habitats within a general project area would require additional permitting (e.g., under Section 404 of the CWA) and would be avoided or minimized by restricting placement of solar energy structures and the associated infrastructure to upland areas (see design features in Appendix B). However, surface grading and other surface disturbances in upland areas could still affect ephemeral streams and runoff channels that provide conveyance to more perennial stream habitats. Ephemeral and intermittent aquatic habitats also provide important seasonal habitat for a variety of organisms, such as insects with aquatic life stages, amphibians, and brachiopod crustaceans (Grippo et al. 2015). Such habitats are especially important in arid environments. (Grippo et al. 2015; Steward et al. 2022). The sensitivity of ephemeral streams to land disturbance varies depending on a variety of factors, including ecological region, topography, soil characteristics, and the presence of rare or unique organisms (O’Connor et al. 2014; Steward et al. 2022). Based on representative projects identified in Section 3.1.1, it is anticipated that water needed during construction of solar PV facilities would range from 0.12 to 3.8 ac-ft per MW. If water for construction activities needed to be withdrawn from waterways on or near the site, the resulting depletions could reduce the amount of aquatic habitat available, depending on the proportion of the available water being withdrawn. Using groundwater during construction could also reduce the quantity of surface water habitat. In some cases, water needs for construction activities could be met by trucking in water from offsite.

Sediment inputs can adversely affect aquatic biota, depending on the species present and the geochemical composition, particle size, concentration, and duration of exposure to the suspended material compared to natural conditions (Waters 1995; Bilotta and Brazier 2008). Increased sediment loads can suffocate aquatic vegetation, invertebrates, and fish; decrease the rate of photosynthesis in plants and phytoplankton and lead to trophic shifts; decrease fish feeding efficiency; decrease the levels of invertebrate prey; reduce fish spawning success; and adversely affect the survival of incubating fish eggs, larvae, and fry as well as invertebrate and amphibian eggs. In addition, some migratory fishes may avoid streams that contain excessive levels of suspended sediments (Waters 1995; Bilotta and Brazier 2008). Removal of riparian vegetation may also result in greater levels of sediment entering the aquatic habitat with which the vegetation is associated. Implementation of design features identified in Appendix B would avoid or minimize such impacts by restricting removal of riparian vegetation for specific projects. It is anticipated that upland areas disturbed during construction of solar energy projects would have a higher erosion potential than undisturbed areas because of site grading and removal of vegetated cover. Fugitive dust from disturbed areas could also contribute turbidity and sedimentation if it settles in aquatic habitats in sufficient quantity (Field et al. 2010). Surface disturbance could occur outside of the project areas due to development of access roads, transmission lines, utility corridors, and similar infrastructure elements. Implementation of measures to control erosion and runoff into aquatic habitats (e.g., silt fences, retention ponds, runoff-control structures, and earthen berms) would reduce the potential for impacts from increased sedimentation. Plans of Development for past solar energy projects on BLM-administered lands have identified procedures and mitigation measures to limit the potential for impacts from erosion, sedimentation, fugitive dust, and runoff into aquatic habitats during construction and operation (e.g., BLM 2018, 2019c, 2021b).

The removal of riparian vegetation, especially taller trees, could potentially affect the temperature regime in aquatic systems by altering the amount of solar radiation that reaches the water surface. This thermal effect may be most pronounced in small stream habitats, where a substantial portion of the stream channel may be shaded by vegetation. The level of thermal impact associated with the clearing of riparian vegetation would be expected to increase as the amount of affected shoreline increases (Pollock et al. 2009). If water temperature increases, the level of dissolved oxygen in the water generally decreases. Consequently, changes in temperature regimes of aquatic habitats can affect the ability of some species to survive within the affected areas, especially during periods of elevated temperatures. Water temperatures during some periods in many aquatic habitats, especially in the desert southwest, may approach levels lethal to resident species under existing conditions. Consequently, alterations to the environment that increase water temperatures in such areas by even a few degrees could result in mortality to aquatic organisms during such periods.

Contaminants could be introduced into aquatic habitats from accidental release of fuels, lubricants, or pesticides/herbicides used during the construction of solar energy projects. Because the concentrations of accidentally introduced contaminants in aquatic habitats will depend largely on the dilution capability and therefore the flow of the receiving waters, impacts would be more likely if contaminated runoff from project areas drains into small perennial streams rather than larger streams. The level of impacts from releases of toxicants would depend on the type and volume of chemicals entering the waterway, the location of the release, the nature of the water body (e.g., size, volume, and flow rates), and the types and life stages of aquatic organisms present in the receiving waterway. However, introduced contaminants can result in direct mortality or sublethal impacts resulting in changes in behavior, reproduction, or endocrine functions. In general, lubricants and fuel would not be expected to enter waterways in appreciable quantities if heavy machinery is not used in or near waterways, fueling locations for construction equipment are situated away from the waterway, and design measures (such as the use of berms, booms, and spill containment kits) are implemented to control spills that do occur.

In areas where access roads, pipelines, or utility corridors cross streams, obstructions to fish movement can occur if culverts, low-water crossings, or buried pipelines are not properly installed, sized, or maintained. During periods of low water, vehicular traffic can result in rutting and accumulation of cobbles in some crossings that can interfere with fish movements. In streams with low flows, flow could become discontinuous if disturbance of the streambed during construction activities results in increased porosity or if alteration of the channel spreads flow across a wider area than usual. Restrictions to fish movement would likely be most significant if they occur in streams supporting species that need to move to specific areas in order to reproduce, or in smaller streams where aquatic organisms may need to move to avoid desiccation or heat stress during low-flow periods. Proper installation, periodic inspections, and maintenance of stream crossings would avoid or minimize such impacts.

In addition to the potential for the direct impacts identified above, indirect impacts on fisheries could occur as a result of increased public access to remote areas via newly constructed access roads and transmission lines. Access to the solar energy project area would likely be restricted by the construction of fences in order to prevent unauthorized access to the site, potentially reducing public access to some waterways. Fishing pressure in surface waters with recreation species could increase if there is greater road access, and other human activities (e.g., OHV use) could disturb riparian vegetation and soils, resulting in erosion and sediment-related impacts on water bodies, as discussed above. In areas where perennial surface waters or intermittent streams connected to perennial surface waters are present, non-native aquatic species may become established because of the new road access either as a result of the use of live bait or unauthorized efforts to stock the waterway with recreational species. Such impacts would be smaller in locations where existing access roads or utility corridors that already provide access to waterways are used. In addition, there is the potential for introducing non-native aquatic species (e.g., fish and mussels) or harmful microbes (e.g., chytrid fungus) via construction or maintenance equipment. Using water from safe sources and decontaminating equipment as appropriate, especially equipment used to convey water (i.e., water pumps), would reduce the risk of introducing harmful aquatic organisms. Design features such as equipment inspections and cleaning and screens for water pumps would be implemented for specific projects, as appropriate, to limit the potential for introducing non-native aquatic species and other potentially harmful organisms (see Appendix B).

5.4.2.1.3 Operations and Maintenance

During the operations and maintenance phase of a utility-scale solar energy facility, aquatic habitats and aquatic biota may be affected by water withdrawn from aquatic habitats for cooling purposes, continued erosion and sedimentation due to altered land surfaces, exposure to contaminants, and continued increases in public access.

Some concerns exist regarding potential impacts of polarized light on insects that have aquatic life stages and deposit eggs in aquatic habitats. Water bodies can polarize reflected light. Consequently, light that has been polarized by reflecting off smooth dark surfaces, such as solar panels, can act as an “ecological trap” in which aquatic insects mistake solar panels for open water and lay eggs on the panel surface (Horváth et al. 2009). In fact, insects can be more attracted to the highly polarized light reflected off solar panels than to natural water bodies (Horváth et al. 2010). Aside from high numbers of insects that may be killed in this way, the significance of the resulting waste of reproductive effort on insect populations is unknown, as is the potential for adverse impacts on higher trophic levels that depend on these insects as food sources. Technological advancements in PV panel design, such as the development of matte solar panels, may reduce the amount of polarized light reflected from solar panels and minimize these impacts on aquatic biota (Száz et al. 2016).

If the project uses water from nearby water bodies or groundwater sources during operation for cleaning PV panels or for other facility purposes, there is a potential for water depletion impacts on aquatic habitats within the vicinity. Based on representative projects identified in Section 3.1.2, water needed during the operation phase of solar PV facilities would range from 0.05 to 0.35 ac-ft/yr per MW. As described in Section 4.4.2, maintaining connectivity among aquatic habitats is an important concern. Changes in the flow patterns of streams and the depletion of surface water resulting from surface or groundwater withdrawal could alter the connectivity among stream networks that serve as important corridors for aquatic biota and can affect the quality of aquatic habitats and the survival of populations of aquatic organisms within affected bodies of water. In addition to a spatial and temporal reduction in available aquatic habitat, the water quality of the remaining habitat could decrease as temperature and solute concentrations increase and dissolved oxygen levels decrease.

Water depletions are of particular concern if protected species would be affected because the potential for negative population-level impacts for rare organisms would be greater than for common and widespread organisms. Water depletion impacts on aquatic resources would depend on the proportion of water withdrawn from a particular water body, the direct and indirect impacts of water withdrawals, and the types of organisms present. If groundwater were used as the water source, there could still be depletion impacts on aquatic habitats such as wetlands, springs, or spring-fed streams that rely on the groundwater source for recharge or the maintenance of baseflow. If water is withdrawn from a surface water source, there is also a potential for impingement and entrainment of aquatic organisms at the water intake and, depending on the numbers of individuals of particular species that are killed, population-level impacts could result. Overall, it is anticipated that the use of water for PV solar energy facilities during the operation phase would be relatively small and depletion impacts on nearby aquatic habitats could be reduced or avoided by using alternate water sources, such as piping in municipal water or trucking water to the site. Design features requiring projects to avoid water withdrawals and implement specific measures in sensitive aquatic habitats (see Appendix B) would avoid or minimize the potential for impacts on such areas during operation of solar energy facilities.

As identified in Section 5.4.2.1.2, the potential for soil erosion and sediment loading of nearby aquatic habitats is, in part, proportional to the amount of surface disturbance and the proximity to aquatic habitats. During the operation phase, some level of vegetation clearing would be required to maintain the site and any associated ROWs for transmission lines. Although the potential for erosion at a given project site and the resulting levels of turbidity and sedimentation in nearby aquatic habitats would likely be less during the operations phase than during the construction phase because of the establishment of some level of ground cover, the levels would be greater than those that occurred preconstruction and would continue throughout the operational life of the project.

The potential exists for toxic materials (e.g., fuel, lubricants, cleaning solutions, and herbicides) to be accidentally introduced into waterways during operation and maintenance of solar energy facilities. The level of impacts from releases of toxicants would depend on the type and volume of chemicals entering the waterway, the location of the release, the nature of the water body (e.g., size, volume, and flow rates), and the types and life stages of organisms present in the waterway. Because the amounts of most fuels and other hazardous materials used at PV facilities are expected to be small, an uncontained spill would probably affect only a limited area. Plans of Development for past solar energy projects on BLM-administered lands have identified procedures and mitigation measures to limit the potential for impacts from spills and herbicide applications during operation (e.g., BLM 2018, 2019c, 2021b). Appendix B includes design features that would require development and implementation of plans to address the potential for contaminants to enter aquatic ecosystems.

5.4.2.1.4 Decommissioning/Reclamation

Decommissioning (including reclamation) of a utility-scale solar energy project would reduce or eliminate impacts that occurred from construction and operation to the extent practicable by re-establishing affected habitat. The effectiveness of any reclamation activity would depend on the specific actions taken; the best results, however, would occur where original site topography, hydrology, soils, and vegetation conditions could be re-established. However, full restoration of site features may not be possible under all situations. Impacts on aquatic habitats and biota during decommissioning activities would be similar to those from construction but may be of more limited scale and shorter duration. This would depend, in part, on whether decommissioning would involve full removal of facilities, partial removal of key components, or abandonment.

Water withdrawals associated with site operations would be discontinued following decommissioning. Depending on the water source used for site operations, impacts may cease immediately or last years to decades. For especially sensitive aquatic habitats, such as seeps and springs, ecosystem impacts of depletion may be irreversible. Temporary increases in the use of vehicles or machinery and in worker foot traffic through aquatic habitats could crush and kill aquatic organisms.

Other potential environmental concerns resulting from decommissioning would include disposal of wastes, hazardous materials, and remediation of any contaminated soils. Some fuel and chemical spills could also occur. The level of impacts from releases of toxicants would depend on the type and volume of chemicals entering a waterway, the location of the release, the nature of the water body (e.g., size, volume, and flow rates), and the types and life stages of organisms present in the waterway. The potential for impacts from chemical spills would be minimized through the use of design features identified in Appendix B. After decommissioning activities were complete, there would be no fuel or chemical spills associated with the solar energy facility.

Whether aquatic habitats would recover from impacts following decommissioning and how long such recovery would take depends on the type and magnitude of potential impacts, the types of habitats that had been affected, and also on the ability of affected populations of organisms to become re-established in restored areas.

5.4.2.1.5 Transmission Lines and Roads

In general, many of the potential impacts on aquatic habitats and biota identified in Sections 5.4.2.1.1 through 5.4.2.1.4 are also applicable to the design, construction, operation, and decommissioning of transmission lines, and to upgrades to existing lines. Potential construction impacts of transmission corridor development on aquatic biota would result primarily from ground disturbance, vegetation removal, and excavation during clearing of the ROWs and from installation of access roads and structures (e.g., transmission line towers, substations, or pipelines) near or in water bodies. Potential impacts could include changes in surface water flow patterns, deposition of sediment in surface water bodies, changes in water quality or temperature regimes, loss of riparian vegetation, introduction of toxic materials, restrictions to fish movements, and changes in human access to water bodies. The severity of impacts would depend on such factors as the type of aquatic habitat and the types of organisms present, season of construction, size of the aquatic habitat, the length and width of the area to be cleared, construction procedures used, and the quality of the existing habitat.

During the operational phase of a project, aquatic systems could be adversely affected by maintenance activities along transmission corridors, especially vegetation control. For most transmission line corridors, vegetation control in a particular area is relatively infrequent (generally no more often than once every 3 to 4 years), and the amount of vegetation disturbed is much less than that which would occur during construction. Selected trees might be removed or trimmed if they are considered likely to pose a risk to the transmission system. If control of vegetation along shorelines can be accomplished through manual techniques, the erosion of stream banks from maintenance activities would be expected to be relatively minor.

The mechanisms by which toxic materials (e.g., fuel, lubricants, and herbicides) could be accidentally introduced into waterways during construction and maintenance activities for transmission corridors would be similar to those described in Sections 5.4.2.1.2 and 5.4.2.1.3. The level of impacts from releases of toxicants would depend on the type and volume of chemicals entering the waterway, the location of the release, the nature of the water body (e.g., size, volume, and flow rates), and the types and life stages of organisms present in the receiving waterway.

Low-water crossings used to accommodate vehicular traffic during construction or maintenance of transmission lines could interfere with fish passage in some cases, as identified in Section 5.4.2.1.2. Potential impacts could be avoided or minimized by installing bridges at water crossings.

Decommissioning of transmission corridors would also result in impacts on aquatic habitats and associated biota. Decommissioning activities would be expected to include the dismantling and removal of structures such as electricity transmission towers. The types of impacts resulting from decommissioning would be similar to those associated with energy project construction, including increased erosion and sedimentation, potential changes to surface water hydrology, potential establishment of invasive species, and potential spills associated with the operation of heavy machinery. Decommissioning activities would generally affect habitat previously disturbed by initial project construction. Depending on the time since initial construction was completed, the type of construction activities that occurred, and the type of aquatic habitat present, the aquatic communities present at the time of decommissioning may closely resemble nearby undisturbed areas. Some aquatic habitats would again recover from the disturbance associated with decommissioning after a period of time. Recovery time could range from months to many years, depending on the nature of the disturbance and the type of aquatic habitats present. Within some ROWs, permanent differences between aquatic communities in disturbed areas and nearby undisturbed areas may remain.

5.4.2.2 Cumulative Impacts

Potentially affected biota in the 11-state planning area includes numerous species of aquatic biota. Under the RFDS, the BLM estimates that a total combined area of approximately 700,000 acres of BLM-administered lands and 600,000 acres of other lands (including private lands and state-owned lands) across the 11-state planning area will host utility-scale PV solar energy development over the next 20 years. The RFDS land-use projections would affect a relatively small proportion of total BLM-administered lands in the planning area. However, species could be affected by loss of habitat, disturbance, loss of food and prey species, loss of reproductive areas, impacts on movement, introduction of new species, and habitat fragmentation. Aquatic habitats and species could be affected by changes in drainage patterns due to site grading and the implementation of stormwater management systems that might divert flows or change runoff quantity to springs, seeps, wetlands, or other aquatic habitats hosting aquatic species. Design features to address these impacts include buffering sensitive habitat from solar energy development, requiring vegetation to be maintained within the project (especially wetlands and riparian areas), timing/activities to protect wetlands or protected species. These design features would reduce, but not eliminate, impacts.

Impacts on aquatic biota from other foreseeable development in the 11-state region could contribute to cumulative impacts. Other types of energy development including oil and gas development, as well as geothermal and wind energy development, would result in habitat loss and disturbance. Other land uses such as livestock grazing, mining, WH&B management areas, and recreational opportunities including OHV use could also cause additional cumulative impacts on aquatic biota.

Overall, contributions to cumulative impacts are expected to be small, provided mitigation measures to preserve important habitat and migration corridors are implemented (or sufficient alternative lands are set aside as compensation). Additionally, because all Action Alternatives except Alternative 1 exclude development on slopes greater than 10%, solar energy facilities would be developed mainly on flat basin floors, habitat that is abundant in the 11-state planning area. Design features required under the BLM Action Alternatives would also require the avoidance of unique or rare habitats and areas containing protected aquatic species. Impacts on aquatic habitats from drainage changes and sedimentation from soil erosion would be mitigated but not eliminated. Large withdrawals of surface water or groundwater that could result in significant impacts on aquatic ecosystems are not expected for PV solar energy facilities (see Section 5.20).

5.4.2.3 Design Features

The BLM has identified design features that will be requirements for all utility-scale solar energy projects on BLM-administered lands subject to the ROD for this Programmatic EIS. The list of design features that have been identified to avoid, minimize, and/or compensate for potential impacts on aquatic biota from solar energy development can be found in Appendix B.4.2.

5.4.2.4 Comparison of Alternatives

Numerous aquatic species may be adversely impacted by alteration of aquatic habitat, disturbance, loss of waterway connectivity, introduction of new species, and changes in water quantity or water quality. Design features (e.g., limiting land disturbance, conducting pre-disturbance surveys, controlling surface water runoff, avoiding sensitive and unique aquatic habitats and riparian areas, and implementing stormwater management and contaminant spill controls) reduce many of these potential impacts.

5.4.2.4.1 No Action Alternative

Under the No Action Alternative, approximately 47.3 million acres of BLM-administered lands would be available for applications for solar energy development. Of the total lands available for application, 330,195 acres are located within existing priority areas, approximately 15.7 million acres are variance lands allocated in the 2012 Western Solar Plan for the six-state planning area, and approximately 31.6 million acres would be available for application within the five additional states considered in this Programmatic EIS, as these lands were not addressed in the 2012 Western Solar Plan. Of the open available lands, under the RFDS the BLM estimates that approximately 700,000 acres (1.4%) of BLM-administered lands will host utility-scale PV solar energy development over the next 20 years. In the six states addressed under the 2012 Western Solar Plan, the design features from that plan would mitigate impacts on aquatic habitats. In the five new states, required mitigation measures for impacts on aquatic habitats would be established at the project-specific level.

5.4.2.4.2 Action Alternatives

Alternative 1. Approximately 55 million acres of BLM-administered lands would be available for utility-scale solar ROW application. The RFDS estimates that solar energy development would occur on approximately 700,000 acres, which is about 1% of the land available for solar ROW application under Alternative 1.

Alternative 1 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria, while making all other lands available for application. Alternative 1 would make more lands available for application than are currently available under the No Action Alternative. The elimination of the slope exclusion could result in additional impacts in comparison to the No Action Alternative for some aquatic biota species indigenous to higher sloped areas.

Updated and more prescriptive design features that may further reduce the magnitude of impacts on aquatic habitats and biota include avoidance of riparian habitat and perennial stream channels; avoidance of unique or rare habitats (e.g., springs and seeps); protection from entrainment and impingement for any surface water withdrawals; minimizing alterations to intermittent and ephemeral stream channels; and controlling potential for project-related sediment and contaminants to enter waterways. These updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 2. Approximately 36.2 million acres of BLM-administered lands would be available for utility-scale solar ROW application. The RFDS estimates that solar energy development would occur only on approximately 700,000 acres, which is about 2% of the lands available for solar ROW application under Alternative 2. Alternative 2 would help the BLM to meet its energy goals by focusing development into areas where resource conflicts would be avoided or reduced by applying resource-based exclusion criteria. and a >10% slope exclusion. The 10% slope exclusion could further limit some impacts on aquatic biota in comparison to Alternative 1 by excluding habitat of species indigenous to these higher sloped areas. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison to the No Action Alternative.

Alternative 3. Approximately 22.2 million acres of BLM-administered lands would be available for utility-scale solar ROW application. The RFDS estimates that solar energy development would occur only on approximately 700,000 acres, which is about 3% of the lands available for solar ROW application under Alternative 3.

Alternative 3 would help the BLM to meet its energy goals by focusing development into areas where resource conflicts would be avoided or reduced by applying resource-based exclusion criteria and a >10% slope exclusion. Changing the slope exclusion criterion from 5% to 10% slope could result in greater impacts in comparison with the No Action Alternative for the six states under the 2012 Western Solar Plan. Alternative 3 would also limit development to areas that are less than 10 miles from existing or planned transmission lines of >100 kV, focusing development in areas that may be more likely to be economically feasible for development. Limiting development to areas that are less than 10 miles from existing and planned transmission lines would limit development to aquatic biota habitat that may already be impacted by edge effects of transmission infrastructure, and thus potentially reduce impacts in comparison with Alternatives 1 and 2.

Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 4. Approximately 11.2 million acres of BLM-administered lands would be available for utility-scale solar ROW application. The RFDS estimates that solar energy development would occur on approximately 700,000 acres, which is about 6% of the lands available for solar ROW application under Alternative 4.

Alternative 4 would help the BLM to meet its energy goals by focusing development into areas where resource conflicts would be avoided or reduced through resource-based exclusion criteria and a >10% slope exclusion. Further, by limiting development to previously disturbed lands, Alternative 4 would potentially avoid higher-quality habitat that might be developed under Alternatives 1 through 3. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 5. Approximately 8.4 million acres of BLM-administered lands would be available for utility-scale solar ROW application. The RFDS estimates that solar energy development would occur only on approximately 700,000 acres, which is about 8% of the lands available for solar ROW application under Alternative 5.

Alternative 5 would help the BLM to meet its energy goals while focusing development into areas where resource conflicts would be avoided or reduced by applying resource-based exclusion criteria and a >10% slope exclusion. Alternative 5 would also combine the requirement that development be limited to areas that are less than 10 miles from existing or planned transmission lines of >100 kV (from Alternative 3) with the requirement to limit development to previously disturbed lands (from Alternative 4), making it the alternative with the least lands available for solar ROW application.

Alternative 5 provides a focus on areas that may be more likely to be economically feasible for development because the lands available are near the transmission grid and limit the amount of new land disturbance. For aquatic biota, Alternative 5 potentially avoids higher-quality habitat by focusing future solar energy development on previously disturbed lands and lands closer to existing or planned transmission. Changing the slope exclusion criterion from 5% to 10% slope could result in greater impacts in comparison with the No Action Alternative for the six states under the 2012 Western Solar Plan. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

5.4.3 Wildlife

5.4.3.1 Direct and Indirect Impacts

All utility-scale solar energy facilities are likely to affect wildlife to some extent. The following discussion provides a brief overview of the potential impacts on wildlife that could occur from the site characterization, construction, operation, and decommissioning of solar energy projects. Similar impacts could occur from transmission lines required to connect solar energy projects to the grid. However, some wildlife impacts would either be unique to a transmission line or be more likely to have a higher magnitude of impact compared with impacts from a solar energy facility. These impacts are discussed in Section 5.4.3.1.5. Current assessments of habitat connectivity will be completed at the project level in order to assess impacts of habitat loss and fragmentation on habitat connectivity, permeability, and resilience. Please see Appendix F.4.3.3 for a more in-depth look at potential impacts on wildlife from solar energy development. The use of design features (see Appendix B) would avoid, minimize, or mitigate impacts on wildlife species and their habitats. Mitigation specifics at the project level would be established through coordination with federal and state agencies and other stakeholders. Impacts on some wildlife may also have implications for recreation due to impacts on hunting and wildlife watching. These impacts are further discussed in Section 5.14.

5.4.3.1.1 Site Characterization

Before a solar energy project and its ancillary facilities (e.g., access roads, transmission lines, and, if necessary, water pipelines) could be constructed, the potential project site areas would have to be precisely characterized, as described in Section 3.2.1. Impacts on wildlife from site evaluation activities would result primarily from disturbance (e.g., due to equipment and vehicle noise and the presence of workers and their vehicles). Such impacts would generally be temporary and at a smaller scale than those during other phases of the project. If drilling or road construction were necessary during this phase, impacts from these activities would be similar in character to those during the construction phase but generally of smaller magnitude. Temporary impoundments for well drilling fluids and cuttings might be authorized. These activities would result in a localized loss of existing wildlife habitat. If a meteorological tower were authorized (especially one requiring guy wires), some bird and bat mortality could be expected. A meteorological tower required for site characterization for a solar energy project would be only about 33–66 ft (10–20 m) tall. Therefore, a large number of bird and bat mortalities would not be expected (this contrasts with large communication towers of 1,000 ft [305 m] or more for which high levels of bird mortality have occurred; see Longcore et al. 2008).

5.4.3.1.2 Construction

Impacts from the construction of a solar energy project, including ancillary facilities (e.g., access roads, transmission lines, and, if necessary, water pipelines), would involve (1) habitat loss, fragmentation, and disturbance; (2) wildlife disturbance; (3) injury or mortality of wildlife; and (4) exposure to trash, contaminants, or fires.

5.4.3.1.3 Operations and Maintenance

The reduction, alteration, and fragmentation of habitat due to the ongoing operational presence of the solar project and ancillary ROWs represent the greatest potential impacts on wildlife. During the operation and maintenance of a utility-scale solar energy facility, wildlife would also be affected by (1) wildlife disturbance (e.g., from ongoing loss of habitat, occasional noise, and the intermittent presence of workers); (2) collisions with aboveground facilities or maintenance vehicles; (3) exposure to or ingestion of contaminants; and (4) the increased potential for fire. Glare could also affect birds at solar energy facilities. While not well studied, glare impacts could range from disorientating a bird in flight, to causing birds in flight to collide with solar panels, to causing eye damage.

5.4.3.1.4 Decommissioning/Reclamation

The decommissioning of solar energy facilities would result in impacts on terrestrial and wetland (if present) plant communities (Section 5.4.1.1.5) and can also impact soils, increase human presence, and can cause short-term increases in dust and noise – all of which could impact wildlife and wildlife habitat. The types of impacts resulting from decommissioning would be similar to those associated with facility construction.

After the short-term impacts of decommissioning, reclamation of a utility-scale solar energy project would reduce or eliminate the impacts from construction and operation to the extent practicable by re-establishing habitat. The effectiveness of any reclamation activity would depend on the specific actions taken, the habitat type, and the ability to respond to reclamation; the best results, however, would occur where original site topography, hydrology, soils, and vegetation patterns could be re-established. Impacts on wildlife from decommissioning activities would be similar to those from construction, but they could be more limited in scale and shorter in duration.

This result would depend, in part, on whether decommissioning would involve full removal of facilities, partial removal of key components, or abandonment. For example, leaving buried components in place (a common industry practice) would reduce the amount of trenching and soil disturbance required and contribute to reduced impacts relative to those that would occur during construction.

5.4.3.1.5 Transmission Lines and Roads

Impacts on wildlife from the site characterization, construction, operation and maintenance, and decommissioning of transmission lines, or during upgrades to existing lines, would be similar to those discussed for solar energy facilities (Sections 5.4.3.1.1–5.4.3.1.4). Potential construction impacts of transmission corridor development on wildlife would result primarily from ground disturbance, vegetation removal, and excavation during clearing of the ROWs and from installation of access roads and structures (e.g., transmission line towers, substations, or pipelines). See Appendix F.4.3.3.4 for potential wildlife impacts that would either be unique to transmission lines or be more likely to have a higher magnitude of impact compared with impacts from solar energy facilities.

5.4.3.1.6 Summary of Common Impacts on Wildlife

Overall, impacts from site characterization, construction, operation, and decommissioning of a solar energy project (including the transmission line) on wildlife populations would depend on the following:

- The type, amount, and location (e.g., migratory corridor, seasonal use area) of wildlife habitat that would be disturbed;
- The nature of the disturbance (e.g., long-term reduction because of project structure and access road placement; complete, long-term alteration due to transmission line, gas pipeline, and water pipeline placement; or temporary disturbance in construction staging areas);
- The wildlife that occupied the facility site and surrounding areas; and
- The timing of construction activities relative to the crucial life stages of wildlife (e.g., breeding season).

In general, impacts on most wildlife species would be proportional to the amount of their specific habitats directly and indirectly disturbed or fragmented. Table 5.4.3-1 summarizes the potential impacts on wildlife species resulting from a solar energy project.

Table 5.4.3-1. Potential Impacts on Wildlife Species Associated with Utility-Scale Solar Energy Facilities, Including Associated Access Roads and Transmission Line Corridors

Impacting Factor	Project Phase	Consequence	Expected Relative Impact[a] for Different Wildlife Communities[b]				Ability to Mitigate Impacts[c]
			None	Small	Moderate	Large	
Individual Impacting Factor[d]							
Alteration of topography and drainage patterns	Construction, operations	Changes in surface temperature, soil moisture, and hydrologic regimes, and distribution and extent of aquatic, wetland, and riparian habitats; erosion; changes in groundwater recharge; spread of invasive species.	None	None	Reptiles, mammals, birds, insects	Amphibians	Can be mitigated by avoiding development of drainages and using appropriate stormwater management strategies.
Human presence and activity	Site characterization, construction, operations, decommissioning	Behavioral disturbance, harassment, nest abandonment, avoidance of areas, territory adjustments, reduction in carrying capacity.	None	None	Amphibians, reptiles, small mammals, insects	Birds, large mammals	Can be mitigated during site characterization and construction by timing activities to avoid sensitive periods. Difficult to mitigate impacts during operations.
Blockage of dispersal and movement	Construction, operations	Genetic isolation, loss of access to important habitats, reduction in diversity, reduction in carrying capacity.	None	None	Amphibians, reptiles, birds, bats, small mammals, insects	Large mammals	Can be mitigated by restricting project size, avoiding important movement corridors, allowing wildlife passage areas in project fencing.
Erosion	Construction, operations, decommissioning	Habitat degradation; loss of plants; sedimentation of adjacent areas especially aquatic, wetland, systems, loss of productivity; reduction in carrying capacity; spread of invasive species.	None	Amphibians, reptiles, birds, mammals, insects	None	None	Can be mitigated with standard erosion control and revegetation practices.
Equipment noise and vibration	Site characterization, construction,	Behavioral disturbance, harassment, nest abandonment, avoidance of	None	Amphibians, reptiles, small mammals, insects	Birds, large mammals	None	Can be mitigated during site characterization and construction by timing activities to avoid sensitive

Impacting Factor	Project Phase	Consequence	Expected Relative Impact[a] for Different Wildlife Communities[b]				Ability to Mitigate Impacts[c]
			None	Small	Moderate	Large	
	operations, decommissioning	areas, territory adjustments, reduction in carrying capacity.					periods. Can be mitigated using mufflers and other sound-dampening devices.
Individual Impacting Factor[d] (Cont.)							
Fugitive dust	Site characterization, construction, operations, decommissioning	Decrease in photosynthesis, reduction in productivity, increase turbidity and sedimentation in aquatic habitat, spread of invasive species, decreased palatability of food for herbivores.	None	Amphibians, reptiles, birds, mammals	Insects	None	Can be mitigated by retaining vegetative cover, soil covers, or soil-stabilizing agents, reducing the number of vehicle passes, and using lower impact construction methodologies.
Groundwater withdrawal	Construction, operations	Change in hydrologic regime, surface subsidence, reduction in surface water, reduction in soil moisture, reduction in productivity.	None	None	Reptiles, birds, mammals, insects	Amphibians	Can be mitigated by reducing water consumption requirements and maintaining vegetation in solar arrays during construction.
Habitat loss	Construction, operations	Elimination of habitat, direct mortality of individuals,	None	None		Amphibians, reptiles, birds, mammals, insects	Can be mitigated by contacting appropriate agencies early in the project planning process to identify and avoid potentially sensitive ecological resources and acquiring and protecting compensation habitat to offset habitat loss.
Habitat fragmentation	Construction, operations	Genetic isolation, loss of access to important habitats, reduction in diversity, reduction in carrying capacity, spread of invasive species.	None	None	Amphibians, reptiles, small mammals, insects	Large mammals, birds	Difficult to mitigate; requires minimizing disruption of intact communities by proper siting of solar facilities and linear features such as transmission lines and roads.

Impacting Factor	Project Phase	Consequence	Expected Relative Impact[a] for Different Wildlife Communities[b]				Ability to Mitigate Impacts[c]
			None	Small	Moderate	Large	
Increased human access	Construction, operations	Harassment, collection, increased predation risk, increased collision mortality risk.	None	None	Amphibians, reptiles, birds, mammals, insects	None	Can be mitigated by reducing the number of new transmission lines and roads in important habitats.
Oil and contaminant spills	Site characterization, construction, operations, decommissioning	Death of directly affected individuals, uptake of toxic materials, reproductive impairment, reduction in carrying capacity.	None	None	Amphibians, reptiles, birds, mammals, insects	None	Can be mitigated using project mitigation measures and spill prevention and response planning.
Project infrastructures	Operations	Increased predation rates from predators using tall structures, collision mortality.	Large mammals	Amphibians	Reptiles, small mammals, insects	Birds	Can be mitigated using appropriate warning lights on towers, markers on lines and guy wires, elimination of guy wires, anti-perching devices, implementing a site-specific bird and bat conservation plan.
Restoration of topography and drainage patterns	Decommissioning	Beneficial changes in temperature, soil moisture, and hydrologic regimes.	None	None	Amphibians, reptiles, birds, mammals, insects	None	Mostly beneficial; adverse impacts can be mitigated by using standard erosion and runoff control measures.
Restoration of topsoil	Decommissioning	Beneficial changes in soil moisture, increased productivity and carrying capacity.	None	None	Amphibians, reptiles, birds, mammals, insects	None	Mostly beneficial; adverse impacts can be mitigated using standard erosion and runoff control measures.
Restoration of native vegetation	Decommissioning	Beneficial changes in soil moisture, increased productivity and carrying capacity, increased diversity.	None	None	Amphibians, reptiles, birds, mammals, insects	None	Mostly beneficial; adverse impacts can be mitigated by ensuring species mix includes a diverse weed-free mix of hardy native species.
Site lighting	Construction, operations	Behavioral disturbance, increased predation of insects, harassment, nest abandonment, avoidance of areas, territory adjustments,	None	Reptiles	Amphibians, diurnal mammals	Birds, insects, nocturnal mammals	Can be mitigated by ensuring lighting is minimized to that needed for safe construction and operations, is ground-directed, and does not

Impacting Factor	Project Phase	Consequence	Expected Relative Impact[a] for Different Wildlife Communities[b]				Ability to Mitigate Impacts[c]
			None	Small	Moderate	Large	
		reduction in carrying capacity, collision with structures.					project past site boundaries.
Soil compaction	Site characterization, construction, operations, decommissioning	Reduction in productivity, reduction in diversity, reduction in carrying capacity, increased runoff and erosion, spread of invasive species.	None	None	Amphibians, reptiles, birds, mammals, insects	None	Can be mitigated by aerating soil after being compacted.
Topsoil removal	Construction, operations	Reduction in productivity, reduction in diversity, reduction in carrying capacity, direct mortality of individuals, increased sedimentation in aquatic habitat, spread of invasive species.	None	None	Amphibians, reptiles, birds, mammals, insects	None	Can be mitigated by stockpiling soils to maintain seed viability, vegetating to reduce erosion, and replacing at appropriate depths when other site activities are complete.
Vegetation clearing	Construction, operations	Elimination of habitat, habitat fragmentation, direct mortality of individuals, loss of prey base, changes in temperature and moisture regimes, erosion, increased fugitive dust emissions, reduction in productivity, reduction in diversity, reduction in carrying capacity, spread of invasive species.	None	None	None	Amphibians, reptiles, birds, mammals, insects	Can be mitigated by implementing mowing alternatives to maintain vegetation on site.
Vegetation maintenance	Operations	Reduction in vegetation cover or vegetation maintained in early successional-stage or low-stature, habitat fragmentation, direct mortality of individuals, reduction in diversity, reduction in carrying capacity, spread of invasive species.	None	None	Amphibians, reptiles, birds, mammals, insects	None	Can be mitigated by managing for low-maintenance vegetation (e.g., native shrubs, grasses, and forbs), invasive species control, minimizing the use of herbicides near sensitive habitats (e.g., aquatic and wetland habitats), using only approved herbicides consistent with safe-application guidelines, and

Impacting Factor	Project Phase	Consequence	Expected Relative Impact[a] for Different Wildlife Communities[b]				Ability to Mitigate Impacts[c]
			None	Small	Moderate	Large	
							using low impact vegetation trimming methods.
Vehicle and equipment emissions	Construction, operations, decommissioning	Reduced productivity.	None	Amphibians, reptiles, birds, mammals, insects	None	None	Readily mitigated by maintaining equipment in proper operating condition.
Vehicle and foot traffic	Site characterization, construction, operations, decommissioning	Direct mortality of individuals through collision or crushing, soil compaction, increased fugitive dust emissions.	None	None	Amphibians, reptiles, birds, mammals, insects	None	Can be mitigated using worker education programs, signage, and traffic restrictions.
All Impacting Factors Combined							
	Site characterization		None	Amphibians, reptiles, birds, mammals, insects	None	None	Relatively easy.
	Construction		None	None	None	Amphibians, reptiles, birds, mammals, insects	Relatively difficult; residual impact mostly dependent on the size of area developed.
	Operations		None	None	None	Amphibians, reptiles, birds, mammals, insects	Relatively difficult; residual impact mostly dependent on the size of area developed.
	Decommissioning		None	None	Amphibians, reptiles, birds, mammals, insects (short-term adverse impacts, long-term benefits)	None	Relatively easy to mitigate adverse impacts of decommissioning. May be difficult to achieve restoration objectives.

Impacting Factor	Project Phase	Consequence	Expected Relative Impact[a] for Different Wildlife Communities[b]				Ability to Mitigate Impacts[c]
			None	Small	Moderate	Large	
	Overall project		None	None	None	Amphibians, reptiles, birds, mammals, insects	Relatively difficult; residual impact mostly dependent on the size of area developed and the success of restoration activities.

[a] Relative impact magnitude categories were based on professional judgment using CEQ regulations for implementing NEPA by defining significance of impacts based on context and intensity. Similar impact magnitude categories and definitions were used in the BLM's NEPA Handbook (BLM 2008a) and Special Status Species Management Manual (BLM 2008b) and assume no wildlife species mitigation. Impact categories were as follows: (1) none—no impact would occur; (2) small—impacts are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource (e.g., ≤1% of the population or its habitat would be lost in the region); (3) moderate—impacts are sufficient to alter noticeably but not to destabilize important attributes of the resource (e.g., >1% but ≤10% of the population or its habitat would be lost in the region); and (4) large—impacts are clearly noticeable and are sufficient to destabilize important attributes of the resource (e.g., >10% of a population or its habitat would be lost in the region). Actual impact magnitudes on wildlife species would depend on the location of projects, project-specific design, application of mitigation measures (including avoidance, minimization, and compensation), and the status of wildlife species and their habitats in project areas.

[b] Wildlife species are placed into groups based on taxonomy (amphibians, reptiles, birds, and mammals). Other categories such as ecological system (aquatic, wetland, riparian, and terrestrial) or size (e.g., small and large mammals) are used when the category is relevant to impact magnitude. Impact magnitude may differ by species within taxonomic groups. Detailed impacts analyses for wildlife species will be determined at the project level.

[c] Actual ability to mitigate impacts will depend on site-specific conditions and the species present in the project area. Recommended mitigation measures are presented in Section 5.4.5.

[d] Impacting factors are presented in alphabetical order.

5.4.3.2 Cumulative Impacts

Potentially affected biota in the 11-state planning area includes numerous species of amphibians and reptiles, birds, mammals, and insects. Under the RFDS, the BLM estimates that a total combined area of approximately 700,000 acres of BLM-administered land and 600,000 acres of other lands (including private lands and state-owned lands) across the 11-state planning area will host utility-scale PV solar energy development over the next 20 years. The RFDS land-use projections would affect a relatively small proportion of total BLM-administered lands in the planning area. However, species would be affected by loss of habitat, disturbance, loss of food and prey species, loss of breeding areas, impacts on movement and migration, introduction of new species, noise, and habitat fragmentation. Some of these impacts could be locally significant. Solar energy facilities could affect bird, bat, big game, and pollinator migration patterns and attract animals to retention ponds. Birds or bats could collide with the solar infrastructure (e.g., solar panels or transmission lines), while the movement of mammals and ground-nesting birds could be affected by project fencing. Transmission towers and lines provide nesting and perching sites, while conductors present collision hazards to birds. Design features to address these impacts include buffering sensitive habitat from solar energy development, requiring vegetation to be maintained within the project, timing of activities to avoid affecting breeding seasons and winter use areas, use of noise-reduction devices, use of wildlife compatible design features for fencing, using measures to reduce bird/bat collisions (e.g., anti-glare film and bird flight diverters) traffic control, and preservation of wetlands. These design features would reduce, but not eliminate, impacts.

Impacts on wildlife are possible from other foreseeable development in the 11-state region and could contribute to cumulative impacts. Other types of energy development including oil and gas development, as well as geothermal and wind energy development, could result in habitat loss and disturbance. Other land uses such as livestock grazing, WH&B HMAs, and recreational opportunities including OHV use, could also cause additional cumulative impacts on wildlife.

However, cumulative impacts including the contributions to those impacts from solar energy development are expected to be small, provided mitigation measures to preserve important habitat and migration corridors are implemented (or sufficient alternative lands are set aside as compensation). In addition, because all Action Alternatives except Alternative 1 exclude development on slopes greater than 10%, solar energy facilities would be developed mainly on flat basin floors, habitat that is abundant in the 11-state planning area. Design features required under the BLM Action Alternative would also require the avoidance of rare habitats.

5.4.3.3 Design Features

The BLM has identified design features that will be requirements for all utility-scale solar energy projects on BLM-administered lands subject to the ROD for this Programmatic EIS. The list of design features that have been identified to avoid,

minimize, and/or compensate for potential impacts on wildlife from solar energy development can be found in Appendix B.4.3.

5.4.3.4 Comparison of Alternatives

Numerous wildlife species are adversely impacted by solar energy development causing loss of habitat, disturbance, loss of food and prey species, loss of breeding areas, effects on movement and migration, introduction of new species, habitat fragmentation, and changes in water availability. Big game migration corridors and big game winter habitat would be available for solar ROW application under any of the alternatives, after application of any exclusions specified in applicable land use plans. A quantitative comparison of big game migration corridors and big game winter habitat was analyzed across all alternatives.

5.4.3.4.1 No Action Alternative

Under the No Action Alternative, 10,993 acres of big game migration corridors overlap with priority areas and approximately 4.7 million acres overlap with lands available for application (these are variance lands in the six states addressed under the 2012 Western Solar Plan). These areas represent 0.04% and 17.3% of the total big game migration corridors on BLM-administered lands within the 11-state planning area, respectively (not including the DRECP/ CDCA; Table 5.4.3-2). Under the No Action Alternative 14,638 acres of big game winter habitat would overlap with BLM priority areas and approximately 15.3 million acres would overlap with lands available for application (variance lands in the 2012 Western Solar Plan states) representing 0.03% and 29% of the total big game winter habitat on BLM-administered lands within the 11-state planning area, respectively (not including the DRECP/CDCA; Table 5.4.3-3).Solar energy development is expected to occur on approximately 700,000 acres (the RFDS value), or 1.4% of lands available for application under the No Action Alternative. In the six states addressed under the 2012 Western Solar Plan, the design features from that plan would mitigate wildlife impacts. In the five new states, required mitigation measures for wildlife impacts would be established at the project-specific level.

Table 5.4.3-2. Big Game Migration Corridors—Comparison Across Alternatives[a]

State	All BLM-Administered Land Intersecting Big Game Migration Corridors (minus DRECP/CDCA)	No Action Alternative: Intersection of Migration Corridors with Priority Areas[b]	No Action Alternative: Intersection of Migration Corridors with Lands Available for Application	Intersection of Migration Corridors with BLM-administered Lands Available for Application in acres				
				Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Arizona	41,787	—	2,107	3,190	2,688	2,688	—	—
California	730,103	—	26,780	66,013	22,743	19,352	4,604	2,893
Colorado	1,844,294	145	6,879	521,396	111,286	89,438	40,089	36,351
Idaho	3,582,494	—	1,867,862	674,937	401,831	346,815	195,587	182,796
Montana[d]	—	—	—	—	—	—	—	—
Nevada	15,116,356	10,848	1,000,677	3,715,434	2,053,753	1,023,921	593,742	328,747
New Mexico	42,515	—	6,373	16,668	9,683	9,227	8,080	7,875
Oregon	2,578,870	—	1,522,273	361,679	193,312	96,055	61,936	46,294
Utah	2,525,666	—	48,422	903,754	269,051	168,885	141,048	113,119
Washington	12,314	—	12,299	10,032	395	288	148	41
Wyoming	566,258	—	164,761	76,631	38,059	34,790	12,485	11,554
Westwide	27,040,657	10,993	4,688,433	6,349,734	3,102,801	1,791,459	1,057,719	729,670

[a] Big game migration corridors identified from the U.S. Geological Survey (USGS 2022b, 2023d) and currently applicable state agency sources (CDFW 2023b; CPW 2022; NDOW 2023; ODFW 2021; UDWR 2023b; WGFD 2023). Includes migration corridors for bighorn sheep, elk, mule deer, pronghorn, and white-tailed deer.
[b] Includes SEZs as amended, solar emphasis areas (BLM 2015a), and the Dry Lake East DLA (87 FR 19699). These total priority area in each state has been updated to reflect changes implemented since 2012 (see Section 1.3).
[c] Variance lands in six-state area.
[d] Data on big game migration corridors in Montana are available from Montana Fish, Wildlife, and Parks (undated). However, the GIS data were not available at prior to the publication of the Draft PEIS.

5.4.3.4.2 Action Alternatives

Alternative 1. Approximately 6.3 million acres of big game migration corridors overlap with BLM-administered lands available for application, representing 23% of the total big game migration corridors on BLM-administered lands within the 11-state planning area (Table 5.4.3-2). Under Alternative 1, approximately 12.8 million acres of big game winter habitat would overlap with lands available for application, representing 24% of the big game winter habitat on BLM-administered lands within the 11-state planning area (Table 5.4.3-3).Under the RFDS solar energy development is expected to occur on approximately 700,000 acres, which is about 1% of the lands available for application under Alternative 1. Some wildlife corridors would be affected by solar energy development ROW applications through reductions in acreage.

Alternative 1 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria, while making all other lands available for application. The elimination of the slope exclusion could result in additional impacts in comparison to the No Action Alternative for some wildlife species indigenous to higher sloped areas.

Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 2. Approximately 3.1 million acres of migration corridors overlap with BLM-administered lands available for application, representing 11% of the total big game migration corridors on BLM-administered lands within the 11-state planning area (Table 5.4.3-2). Under Alternative 2, approximately 6.2 million acres of big game winter habitat would overlap with BLM-administered lands available for application, representing 12% of the big game winter habitat on BLM-administered lands within the 11-state planning area (Table 5.4.3-3). Under the RFDS solar energy development is expected to occur on approximately 700,000 acres, which is about 2% of the lands available for application under Alternative 2. Some wildlife corridors would be affected by solar energy development ROW authorizations through reductions in acreage.

Alternative 2 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria. The 10% slope exclusion could further limit some impacts on aquatic biota in comparison to Alternative 1 by excluding habitat of species indigenous to these higher sloped areas. Changing the slope exclusion criterion from 5% to 10% slope could result in greater impacts in comparison with the No Action Alternative for the six states under the 2012 Western Solar Plan.

Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Table 5.4.3-3. Winter Habitat - Comparison Across Alternatives[a]

State	All BLM-Administered Land Intersecting Big Game Winter Habitat (minus DRECP/CDCA)	No Action Alternative: Intersection of Big Game Winter Habitat with Priority Areas[b]	No Action Alternative: Intersection of Big Game Winter Habitat Lands Available for Application[c]	Intersection of Big Game Winter Habitat with BLM-administered Lands Available for Application in acres				
				Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Arizona	74,652	—	5,765	10,319	7,477	7,477	—	—
California	88,356	—	2,304	14,418	2,376	146	1,456	146
Colorado	5,523,555	14,605	72,672	1,561,693	449,095	283,324	188,338	132,453
Idaho	1,406	—	564	63	1	1	1	1
Montana	6,370,992	—	3,205,570	898,152	378,512	126,668	259,846	90,948
Nevada	12,253,534	33	552,979	3,301,327	1,472,785	736,044	252,418	125,387
New Mexico	102,397	—	22,356	46,646	28,990	28,550	19,925	19,521
Oregon	6,765,372	—	4,552,431	885,790	360,337	230,158	158,422	117,229
Utah	7,813,711	—	115,312	2,291,003	704,326	559,070	385,291	339,634
Washington	8,227	—	8,227	7,270	310	235	146	71
Wyoming	13,609,409	—	6,755,387	3,819,909	2,790,347	2,081,193	1,179,079	1,008,530
Westwide	52,611,611	14,638	15,293,567	12,836,590	6,194,556	4,052,866	2,444,922	1,833,920

[a] Big game winter habitat identified from USGS (USGS 2022b, 2023d) and currently applicable state agency sources (CDFW 2023b; CPW 2022; MFWP 2023a; NDOW 2023; ODFW 2021; UDWR 2023b; WGFD 2023). Includes winter habitat for bighorn sheep, bison, elk, moose, mountain goat, mule deer, pronghorn, and white-tailed deer.

[b] Includes SEZs as amended, solar emphasis areas (BLM 2015a), and the Dry Lake East DLA (87 FR 19699). These total priority area in each state has been updated to reflect changes implemented since 2012 (see Section 1.3).

[c] Variance lands in six-state area.

Alternative 3. Approximately 1.8 million acres of migration corridors overlap with BLM-administered lands available for application, representing 7% of the total big game migration corridors on BLM-administered lands within the 11-state planning area (Table 5.4.3-2). Under Alternative 3, approximately 4 million acres of big game winter habitat would overlap with lands available for application, representing 8% of the big game winter habitat on BLM-administered lands within the 11-state planning area (Table 5.4.3-3). Under the RFDS solar energy development is expected to occur on approximately 700,000 acres, which is about 3% of the lands available for application under Alternative 3. Some wildlife corridors would be affected by solar energy development ROW authorizations through reductions in acreage.

Alternative 3 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a 10% slope exclusion. Changing the slope exclusion criterion from 5% to 10% slope could result in greater impacts in comparison with the No Action Alternative for the six states under the 2012 Western Solar Plan. Alternative 3 would also limit development to areas that are less than 10 miles from existing or planned transmission lines of >100 kV, focusing development in areas that may be more likely to be economically feasible for development and limiting development to wildlife habitat that may already be impacted by edge effects of transmission infrastructure, and thus potentially reduce impacts in comparison with Alternatives 1 and 2.

Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 4. Approximately 1 million acres of big game migration corridors overlap with BLM-administered lands available for application, representing 4% of the total big game migration corridors on BLM-administered lands within the 11-state planning area (Table 5.4.3-2). Under Alternative 4, approximately 2.4 million acres of big game winter habitat would overlap with lands available for application representing 5% of the big game winter habitat on BLM-administered lands within the 11-state planning area (Table 5.4.3-3). Under the RFDS solar energy development is expected to occur only on approximately 700,000 acres, which is about 6% of the lands available for solar ROW application under Alternative 4. Some wildlife corridors would be affected by solar energy development ROW authorizations through reductions in acreage.

Alternative 4 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria anda 10% slope exclusion. Further, by limiting development to previously disturbed lands, Alternative 4 would likely avoid higher-quality habitat by focusing on previously disturbed lands. Changing the slope exclusion criterion from 5% to 10% slope could result in greater impacts in comparison with the No Action Alternative for the six states under the 2012 Western Solar Plan. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 5. Approximately 730,000 acres of big game migration corridors overlap with lands available for application, representing 3% of the total big game migration corridors on BLM-administered lands within the 11-state planning area (Table 5.4.3-2). Under Alternative 5, approximately 1.8 million acres of big game winter habitat would overlap with lands available for application, representing 3% of the big game winter habitat on BLM-administered lands within the 11-state planning area (Table 5.4.3-3). Under the RFDS solar energy development is expected to occur only on approximately 700,000 acres, which is about 8% of the lands available for solar ROW application under Alternative 5. Some wildlife corridors would be affected by solar energy development ROW authorizations through reductions in acreage.

Alternative 5 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria, and a 10% slope exclusion. Alternative 5 would also combine the requirement that development be limited to areas that are less than 10 miles from existing or planned transmission lines of >100 kV (from Alternative 3) with the requirement to limit development to previously disturbed lands (from Alternative 4), making it the alternative with the least lands available for solar ROW application, but also the lowest levels of wildlife conflicts.

Alternative 5 provides a focus on areas that may be more likely to be economically feasible for development because the BLM-administered lands available are near the transmission grid and limit the amount of new land disturbance. For wildlife, Alternative 5 likely avoids higher-quality wildlife habitat by focusing on previously disturbed lands and lands closer to existing or planned transmission. Changing the slope exclusion criterion from 5% to 10% slope could result in greater impacts in comparison with the No Action Alternative for the six states under the 2012 Western Solar Plan. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

5.4.4 Special Status Species (SSS)

5.4.4.1 Direct and Indirect Impacts

Numerous SSS (Section 4.4.4) are present within the 11-state planning area that could be affected by solar energy development. Impacts on SSS that could result from utility-scale solar energy development include those associated with initial site characterization, facility construction, operations, and decommissioning. Impacts on SSS are fundamentally similar to or the same as those described for impacts on plant communities and habitats, wildlife, and aquatic resources (Sections 5.4.1, 5.4.2, and 5.4.3, respectively). However, because of their small population and often specialized habitat needs or dependence on rare habitats, SSS may be more vulnerable to impacts than common and widespread species. Small population size makes them more vulnerable to the impacts of habitat fragmentation, habitat alteration, habitat degradation, human disturbance and harassment, mortality of individuals, and the loss of genetic diversity. Therefore, the impact magnitude presented in Table 5.4.3-1 may differ between ESA proposed/listed species and other species. A "small" impact to a non-listed species may be significant and adverse at the individual level to a listed species. For project specific applications, a detailed effects analysis and Biological Opinion will be provided for each ESA listed species during ESA section 7 consultation.

General impacts on SSS are discussed separately for each project phase in the following sections. Impacts by alternative are discussed in Section 5.4.4. All designated critical habitat that has been mapped by the U.S. Fish and Wildlife Service (USFWS) is excluded. Under the No Action Alternative, this exclusion applies in the six southern states, and under all action alternatives the exclusion applies to the 11-state planning area. For designated critical habitat areas that have not yet been mapped, no GIS data are yet available. These areas are still excluded, but by text only. In addition, proposed critical habitat is recommended for exclusion by the USFWS. All known occupied habitat for ESA-listed species, based on current available information or surveys of project areas, is also excluded from solar energy development. GIS data for known occupied habitat is not available for all listed species, but these areas are still excluded.

For BLM sensitive species, the following areas are excluded from solar energy development: all areas where the BLM has agreements with the USFWS and/or state agency partners and other entities to manage sensitive species habitat in a manner that would preclude solar energy development, including habitat protection and other recommendations in conservation agreements/strategies. Sensitive habitat areas to be excluded would be identified based on local and project level analysis.

The discussion in this section assumes that no mitigation would occur. In reality, there are actions required by the BLM and a number of federal and state laws and regulations that would entail consultation with federal and state natural resource agencies, resulting in project-specific modifications to proposed projects that will avoid, minimize and mitigate many of the impacts described here. For a description of design features applicable to solar projects see Appendix B.

5.4.4.1.1 Site Characterization

Site characterization activities may require ground disturbances activities including geotechnical exploration, the installation of groundwater monitoring wells (for those projects that anticipate the use of groundwater) or the construction of meteorological towers to obtain climatic data for projects in remote areas. In addition to ground disturbance, increased human presence in the area may affect local populations of special status plants and animals through collection, inadvertent or unintentional harassment, and/or crushing, injury, or mortality from vehicles or construction materials and equipment.

5.4.4.1.2 Construction

Construction techniques that minimize land surface disturbance, (such as avoiding grading, leaving natural contours of the site in place, and mowing vegetation rather than removing it) will be employed. Nonetheless, construction activities could remove suitable habitat for special status plant and animal species (note that, in actual practice, mitigation will include avoidance and protection of occupied or suitable habitats for

SSS). The estimated land area requirements for facilities using PV technologies assumes 4–7 acres/MW and facility sizes of 5–750 MW (Section 3.1.2). Storage could add an additional 1 acre/MW. The altered land area would be maintained throughout the life of the facility, representing a direct loss and fragmentation of habitat and productivity on the site and creating a barrier to movements of many SSS species. Projects that are able to maintain vegetation or provide vegetated strips of land between groups of solar panels could provide some marginal habitat for some SSS.

The discussion of construction related impacts on vegetation (Section 5.4.1), aquatic species (Section 5.4.2), and wildlife (Section 5.4.3) are applicable to SSS. For SSS plants, these impacts include physical removal of vegetation, crushing/mortality of individual plants, soil erosion, fugitive dust, vehicle emission and contaminant releases, and the introduction of invasive plant species. These activities may also affect aquatic habitats by increasing runoff and sedimentation. For wildlife, smaller animals, slow moving animals, and burrowing animals (e.g., tortoises, lizards, snakes, and amphibians), are more likely to be killed during clearing and construction activities while more mobile animals such as birds and medium-sized or large mammals would be most likely to leave the project area during site preparation and construction activities and development of the site would represent a loss and fragmentation of habitat for these species or a reduction in habitat quality. However, if construction happens during breeding, nesting, or denning periods, direct mortality and loss of offspring may occur.

5.4.4.1.3 Operations and Maintenance

Potential project operations impacts described in Sections 5.4.1 to 5.4.3 are applicable to SSS. Throughout the operational period, the site would have reduced plant cover, and the entire site would be fenced. This would represent a direct loss of habitat and productivity on the site and create a barrier to most wildlife movements. Further, the developed site would fragment otherwise intact habitat and, in many cases, isolate the remaining suitable habitat patches from one another. If water for panel washing were obtained from an offsite location rather than an onsite well, a water pipeline might be required. Unless buried, a pipeline may cause habitat loss and fragmentation during the anticipated operational lifespan of the solar energy project (greater than 20 years).

Special status animals in and adjacent to project areas would be disturbed by human activities, including noise, physical removal of vegetation, crushing/mortality of individual plants, soil erosion, fugitive dust, vehicle emission and contaminant releases, the introduction of invasive plant species and site lighting, and are likely to avoid the area while activities are occurring for the life of the solar energy facility. Fugitive dust, runoff, erosion, and sedimentation into adjacent habitats could also affect SSS. Natural runoff patterns would also be affected by such developments, which could influence offsite plant communities and habitats through erosion and sedimentation. Plants in adjacent habitats could also be affected by the deposition of fugitive dust or other particulates.

PV solar energy projects do not require water for generating electricity, but water is required for panel washing. Withdrawals from surface water sources may alter hydrological regimes and affect local plant and animal species. Groundwater withdrawals to support operational needs could result in drawdown of aquifers and subsequent reductions in stream and other surface water levels, thereby reducing aquatic habitat availability and quality, and affect wetlands, springs, and riparian habitats dependent on those water levels. However, the likelihood of such impacts would be low for PV, especially compared to other solar technologies (e.g., wet-cooled parabolic trough or power tower).

5.4.4.1.4 Decommissioning/Reclamation

In general, the impacts on SSS plant and animal species associated with decommissioning of utility-scale solar energy facilities would be short-term and similar to those associated with facility construction. Decommissioning activities would occur only in areas previously disturbed by project construction activities and operations, although adjacent areas could be affected.

Impacts associated with decommissioning activities include soil disturbances, fugitive dust, human presence, traffic, noise, and vehicle collisions. Decommissioning activities also would include reclamation efforts. During this phase, the site would be regraded if needed and revegetated with native species in attempts to restore the site to pre-disturbance conditions. Other reclamation activities could include re-establishing natural drainage and hydrological processes and limiting human access to the site. Although reclamation efforts may increase habitat availability and quality from project operation conditions, it may take many years for the project site to be fully restored to pre-disturbance conditions. In many cases, especially in arid environments, reclamation may never be successful and habitat quality may be reduced by invasive, non-native plant species. Consequently, beneficial non-native may be planted following consultations with the state wildlife agency when non-native plants can be beneficial (especially considering a changing climate).

5.4.4.1.5 Transmission Lines and Roads

The impacts on SSS from the construction of transmission lines and ROW maintenance, and from upgrades to existing lines, associated with utility-scale solar energy projects would be similar to those from other activities described in the previous sections. Potential construction impacts of transmission corridor and road development on sensitive species would result primarily from ground disturbance, vegetation removal, and excavation during clearing of the ROWs and from installation of access roads and structures (e.g., transmission line towers and substations). Impacts on SSS resulting from transmission line and road construction, operation, and maintenance could include the following:

- Habitat fragmentation, destruction or degradation, altered topography, altered hydrologic patterns, soil removal and/or erosion, sedimentation, fugitive dust, and contaminant spills.
- Disturbance and harassment of animals from noise and human activities during transmission line construction and ROW maintenance operations.

- Increased predation of SSS resulting from the increase in localized predator populations. Such predators (e.g., raccoons, skunks) are attracted to habitat edges established by transmission line corridors.
- Special status aquatic species may be affected by increases in water temperature in areas crossed by transmission facilities resulting from the removal of riparian vegetation that would otherwise shade surface water.
- Special status plant and animal species may be affected by the spread of invasive exotic species in or near areas that have been disturbed by activities associated with transmission line construction and/or maintenance.
- Mortality associated with vehicle collisions along roads or off-road during construction and operation of project area and access roads and transmission lines.
- Mortality to birds following their collision with transmission lines.

5.4.4.2 Cumulative Impacts

Under the RFDS, the BLM estimates that a total combined area of approximately 700,000 acres of BLM-administered land and 600,000 acres of other lands (including private lands and state-owned lands) across the 11-state planning area will host utility-scale PV solar energy development over the next 20 years. The RFDS land-use projections would affect a relatively small proportion of total BLM-administered lands in the 11-state planning area. However, cumulative impacts on SSS from PV solar energy development could occur due to the large, continuous areas disturbed, and disturbance from associated roads and transmission lines. SSS, those given special protections under the ESA or identified as sensitive species by the affected states or the BLM, are present in much of the 11-state planning area.

Exclusion areas include critical habitat (designated and proposed) for federally listed species. Developers are also required to implement a threatened and endangered species protection plan at each project location in consultation with federal agencies. Project developers must also provide compensatory mitigation for loss of habitat for federally listed species. Mitigation may be in the form of land acquisition and/or funding/implementing conservation actions that will benefit the recovery of federally listed species.

For all SSS, design features require developers to site project facilities, infrastructure, and activities out of occupied habitats and corridors of special status animal and plant species to the maximum extent practicable. In addition, projects would avoid habitats and surface water or groundwater uses that affect habitats occupied by SSS. Developers are also required to conduct pre-construction surveys for SSS, in coordination with the BLM, USFWS, and state agencies. If avoiding or minimizing impacts on occupied habitats is not feasible, then translocation of individuals from areas of direct impact, compensatory mitigation of direct impacts on occupied habitats, or other mitigation could reduce impacts. A comprehensive mitigation strategy for SSS that uses one or more of these options to offset the impacts of development will be developed in coordination with the appropriate federal and state agencies.

Impacts are possible from other foreseeable development in the 11-state region and could contribute to cumulative impacts. Other types of energy development including oil and gas development, as well as geothermal and wind energy development, could result in habitat loss and disturbance. Other land uses such as livestock grazing, WH&B HMAs, and recreational opportunities including OHV use, could also cause additional cumulative impacts on SSS. For example, in some areas, large ungulates are documented to have caused trampling of special status plants. Cumulative impacts are expected to be small to moderate for some species, with solar energy development being a major contributor to cumulative impacts. Impacts would largely be determined by the successful implementation of required design features that would avoid and minimize impacts on SSS during siting, construction, and operations, as well as mitigation measures such as SSS habitat restoration and species translocation.

5.4.4.3 Design Features and Additional Mitigation Measures

Numerous SSS may be adversely impacted by solar energy development. Multiple exclusions avoid such impacts in specific locations, including critical habitat. The BLM has identified design features that will be requirements for all utility-scale solar energy projects on BLM-administered lands subject to the ROD for this Programmatic EIS. These design features (e.g., limiting land disturbance, conducting pre-disturbance surveys, controlling surface water runoff) will also reduce many of these impacts. The list of design features that have been identified to avoid, minimize, and/or compensate for potential impacts on SSS from solar energy development can be found in Appendix B.4.4.

In addition to the design features, the following mitigation measures may be useful in avoiding, minimizing, and/or mitigating some impacts on SSS resources:

- Project developers should avoid to the extent practicable all solar energy development activities in Priority 1 and 2 desert tortoise habitat (BLM 2012) and identified desert tortoise project areas that will result in removal of habitat supporting more than 5 adult tortoises. The number of desert tortoises on-site is based on estimates derived from the protocol surveys described previously using the USFWS's pre-project survey protocol (USFWS 2019, or most recent). These design features apply to any solar energy development applications within modeled desert tortoise habitat with a suitability index ≥ 0.5 (Nussear et al. 2009 or most recent as approved by permitting agencies) or habitat supporting ≥ 5 tortoises per square-mile (number of tortoises is based on estimates derived from the USFWS pre-project survey protocol (USFWS 2019 or most recent).
- Project developers should cap ground disturbance on Priority 2 desert tortoise habitat (BLM 2012) as well as within identified BLM desert tortoise "recovery project areas" to <1% of each individual area (similar approach described in BLM 2016n) calculated on BLM-administered land.

- Project developers should avoid to the extent practicable all solar energy development activities within 0.5 miles of known Mexican spotted owl Protected Activity Centers.
- Project developers should collect and appropriately store native plant seed within and around approved project sites within Mojave desert tortoise habitat to ensure availability for habitat restoration needs.
- Project developers should avoid to the extent practicable all solar energy development activities within the range map areas for endangered Mexican long-nosed bat (*Leptonycteris nivalis*; USFWS 2023f).

5.4.4.4 Comparison of Alternatives

This section compares potential impacts on SSS by alternative. SSS have the potential to be significantly impacted through direct and indirect impacts during all project phases. This Solar Programmatic EIS does not provide a detailed impact analysis for individual species. Avoiding, minimizing, and mitigating impacts on SSS will occur during the planning and permitting stages for individual projects and as such, species-specific analysis is beyond the scope of this Programmatic EIS. Actions required by the BLM and a number of federal and state laws and regulations would entail consultation with federal and state natural resource agencies, resulting in project-specific modifications to proposed projects that would avoid, minimize and mitigate many of the impacts.

Consultation with the USFWS under Section 7 of the ESA is required for those species currently listed under the ESA; coordination with the USFWS should be conducted for those species that are candidates, proposed, or under review for listing under the ESA. The consultation process includes the development of a biological assessment (BA), which is a document prepared to determine whether the proposed federal action is likely to adversely affect listed species, proposed species, or designated critical habitat. As a result of the BA and the consultation process, the USFWS will form a biological opinion formally stating whether or not the federal action is likely to jeopardize the continued existence of listed or proposed species or result in the destruction of adverse modification of critical habitat. The USFWS will review the BA and determine whether to concur with any "not likely to adversely affect" determinations and, relative to any "likely to adversely affect" determinations, will determine over the course of formal consultation whether or not the proposed action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat.

Impacts on ESA listed species were compared by alternative using a GIS analysis in which the ranges of listed species from USFWS’s Environmental Conservation Online System (ECOS; USFWS 2023g) were compared to the boundaries of each alternative. All species whose range overlaps the alternative boundary were considered to be potentially affected by solar energy development. Therefore, increased potential for impacts on ESA listed species (collectively) would be anticipated for alternatives where more land available for solar applications intersects with a greater number of these species' range(s). These are screening-level assessments of potential impacts on species, indicating only general areas where species may be present. At the project level avoidance of specific species ranges that occur within project ROW would be implemented where possible, as well as other mitigation measures.

For BLM sensitive species, their county level occurrence data could not be obtained for multiple states. Consequently, there are multiple states for which species counts are not available by alternative. For states where county level data were available, most alternatives had similar numbers of species potentially affected, most likely because county level data lacked the spatial resolution to adequately distinguish the alternatives. Therefore, the data for BLM sensitive species are of limited utility for alternative comparison and the discussion will focus on ESA listed species. Potential impacts on BLM and state-listed species will be addressed during project-specific evaluations.

5.4.4.4.1 No Action Alternative

Critical habitat for ESA listed species is currently excluded from solar energy development in the six states addressed under the 2012 Western Solar Plan, which provides an important initial mitigation of potential impacts on these species in these states. In the five states not evaluated in the 2012 Western Solar Plan, critical habitat areas could be available for solar energy development, unless the protection afforded by designation of critical habitat under the ESA or other restrictions would preclude it, so impacts on ESA listed species are potentially greater under the No Action Alternative in these states.

Based on species ranges from the USFWS, under the No Action Alternative, the priority areas available (330,195 acres) overlap with habitats of 48 ESA listed species (11% of all ESA listed species in the planning area). The other BLM-administered lands available for utility-scale solar ROW application (approximately 47.3 million acres) overlap with 408 ESA listed species (96% of all ESA listed species in the planning area; Table 5.4.4-1). For the BLM-administered lands within the five states not evaluated in the 2012 Western Solar Plan, all BLM-administered lands would be available, unless other exclusions apply. Of the lands available for application, under the RFDS the BLM estimates that approximately 700,000 acres (1.5%) of BLM-administered lands will host utility-scale PV solar energy development over the next 20 years. In the six states addressed under the 2012 Western Solar Plan, the design features from that plan would mitigate impacts on SSS. In the five new states, required mitigation measures for impacts on SSS would be established at the project-specific level.

Table 5.4.4-1. Count of ESA Listed Species Potentially Affected by Solar Energy Development on BLM-Administered Lands in the 11-State Planning Area[a]

State	No. of Species with Ranges in All BLM-Administered Land (minus DRECP/CDCA)	No Action Alternative: No. of Species with Ranges in Priority Areas[b]	No Action Alternative: No. of Species with Ranges in Lands Available for Application[c]	No. of Species Potentially Affected				
				Alternative 1:	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Arizona	66	33	60	55	53	48	48	45
California	221		205	173	120	112	112	107
Colorado	46	6	44	41	39	37	35	34
Idaho	21	NA[d]	21	19	15	15	15	15
Montana	17	NA[d]	17	16	15	15	15	15
Nevada	72	13	63	58	58	51	52	46
New Mexico	71	4	69	66	66	62	62	59
Oregon	46	NA[d]	46	44	38	38	38	37
Utah	50	6	49	49	44	41	40	38
Washington	29	NA[d]	28	22	17	17	17	17
Wyoming	28	NA[d]	28	28	27	26	26	26
Westwide[e]	**425**	**48**	**407**	375	312	300	297	287

[a] Includes SEZs as amended, solar emphasis areas (BLM 2015), and the Dry Lake East DLA (BLM 2019a. These total priority area in each state has been updated to reflect changes implemented since 2012 (see Section 1.3).

[b] This is a count of the listed species in the 11-state planning area that have ranges intersecting with the lands available for application under each alternative. At the project-level, avoidance of these range areas would be considered. Note that none of the alternatives include critical habitat for these species, which is excluded under all alternatives.

[c] Variance lands within the six-state area.

[d] No priority areas have been identified for this state.

[e] State ESA species do not sum to the Westwide total because the same species are listed in multiple states.

5.4.4.4.2 Action Alternatives

Critical habitat (mapped or unmapped) for ESA listed species is excluded from solar energy development under each action alternative, which provides an important initial mitigation of potential impacts on species that have designated critical habitat. About half of all ESA listed species do not have designated critical habitat and many have critical habitat designations are outdated. In addition to critical habitat, known occupied habitat for ESA-listed species, based on current available information or surveys of project areas, is excluded from solar energy development. Suitable habitat for ESA listed species, where ESA listed species occupancy is unknown, would be evaluated on a project specific basis and any occupied habitat would be subject to the exclusion.

For each action alternative, an analysis of the number of ESA listed species potentially impacted was conducted based on the overlap of the species ranges with the public land available under the alternative (Table 5.4.2-1).

Alternative 1. Approximately 55 million acres of BLM-administered lands would be available for utility-scale solar ROW application. The BLM-administered lands available for application overlap with habitats of 375 ESA listed species (88% of all ESA species in the planning area; Table 5.4.4-1). Of the action alternatives, Alternative 1 would potentially affect the greatest number of ESA listed species.

The RFDS estimates that solar energy development would occur only on approximately 700,000 acres, which is about 1% of the land available for solar ROW application under Alternative 1. Alternative 1 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria, while making all other BLM-administered lands available for application. Alternative 1 would make more lands available for application than under the No Action Alternative. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 2. Approximately 36.2 million acres of BLM-administered lands would be available for utility-scale solar ROW application. The lands available for application overlap with habitats of 312 ESA listed species (73% of all ESA species in the planning area; Table 5.4.4-1). Of the action alternatives, Alternative 2 would potentially affect the second highest number of ESA listed species. The RFDS estimates that solar energy development would occur only on approximately 700,000 acres, which is about 2% of the lands available for solar ROW application under Alternative 2.

Alternative 2 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a >10% slope exclusion. The 10% slope exclusion could further limit some impacts on SSS in comparison to Alternative 1 by excluding habitat of species indigenous to these higher sloped areas. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 3. Approximately 22.2 million acres of BLM-administered lands would be available for utility-scale solar ROW application. The lands available for application overlap with habitats of 300 ESA listed species (71% of all ESA species in the planning area; Table 5.4.4-1). Of the action alternatives, Alternative 3 would potentially affect the third highest number of ESA listed species. The RFDS estimates that solar energy development would occur only on approximately 700,000 acres, which is about 3% of the lands available for solar ROW application under Alternative 3.

Alternative 3 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a >10% slope exclusion. Changing the slope exclusion criterion from 5% to 10% slope could result in greater impacts in comparison with the No Action Alternative for the six states under the 2012 Western Solar Plan. Alternative 3 would also limit development to areas that are less than 10 miles from existing or planned transmission lines of >100 kV, focusing development in areas that may be more likely to be economically feasible for development. Limiting development to areas that are less than 10 miles from existing and planned transmission lines would limit development to special species habitat that may already be impacted by edge effects of transmission infrastructure, and thus potentially reduce impacts in comparison with Alternatives 1 and 2.

Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 4. Approximately 11.2 million acres of BLM-administered lands would be available for utility-scale solar ROW application. The lands available for application overlap with habitats of 297 ESA listed species (70% of all ESA species in the planning area; Table 5.4.4-1). Of the action alternatives, Alternative 4 would potentially affect the third highest number of ESA listed species, the same number as Alternative 3. The RFDS estimates that solar energy development would occur on approximately 700,000 acres, which is about 6% of the lands available for solar ROW application under Alternative 4.

Alternative 4 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a >10% slope exclusions. Further, by limiting development to previously disturbed lands, Alternative 4 would potentially avoid higher-quality habitat that might be developed under Alternatives 1 through 3. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 5. Approximately 8.4 million acres of BLM-administered lands would be available for utility-scale solar ROW application. The lands available for application overlap with habitats of 287 ESA listed species (68% of all ESA species in the planning area; Table 5.4.4-1). Of the action alternatives, Alternative 5 would affect the fewest number of ESA listed species. The RFDS estimates that solar energy development would occur only on approximately 700,000 acres, which is about 8% of the lands available for solar ROW application under Alternative 5.

Alternative 5 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a >10% slope exclusion. Alternative 5 would also combine the requirement that development be limited to areas that are less than 10 miles from existing or planned transmission lines of >100 kV (from Alternative 3) with the requirement to limit development to areas with previously disturbed lands (from Alternative 4), making it the alternative with the least lands available for solar ROW application.

Alternative 5 provides a focus on areas that may be more likely to be economically feasible for development because the lands available are near the transmission grid and limit the amount of new land disturbance. For SSS, Alternative 5 potentially avoids higher-quality habitat by focusing future solar energy development on previously disturbed lands and lands closer to existing or planned transmission. Changing the slope exclusion criterion from 5% to 10% slope could result in greater impacts in comparison with the No Action Alternative for the six states under the 2012 Western Solar Plan. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

5.5 Environmental Justice

5.5.1 Direct and Indirect Impacts

Processes and decisions related to utility-scale solar energy siting, production, distribution, and decommissioning may contribute to disproportionate environmental injustices within and beyond the 11-state region (Church and Crawford 2020). The following subsections identify potential impacts from solar energy development across multiple resource factors that could adversely and disproportionately impact minority, low-income, and Tribal populations related to utility scale PV solar energy development in the 11 western states (for additional impacts specific to Tribal communities, please refer to Section 5.18). Using key environmental factors (such as air quality, water resources, and soil resources) along with cultural and socioeconomic factors, and incorporating examples from relevant resource areas in this Programmatic EIS, the following subsections describe a range of factors that could have potentially adverse and disproportionate impacts on health, cultural and spiritual practices, recreational benefits, and economic growth and stability on communities with EJ concerns.

For each subsection discussed below, cumulative factors (e.g., long-term exposure to, and adverse health impacts from, environmental contaminants; and loss of ancestral lands and sense of place) may amplify adverse impacts and shift determinations of proportional impact. These factors are highly contextual and, therefore, future project-oriented NEPA review will require additional local data, collected in collaboration with potentially affected minority, low-income, and Tribal community/ies, to assess whether and the extent to which project-specific actions adversely affect populations with EJ concerns (see BLM 2022d for more information on how to identify, and conduct outreach and engagement with, populations who may have potential EJ concerns that are relevant to a possible utility-scale solar project).

For state level population numbers and/or percentages of minority and low-income populations with potential EJ concerns, please refer to Section 4.15 and Appendix F.5.3. For data identifying low-income and minority populations at the Census block group level within proximity to lands available for utility scale solar development, please refer to Appendix F.5.3.

5.5.1.1 Air Quality and Climate

5.5.1.1.1 Air Quality – Fugitive Dust

Although most states have standards for controlling the release of fugitive dust at industrial sites, unmitigated fugitive dust could occur over the life of a PV project, i.e., from site characterization, construction, operation, to decommissioning. Among them, fugitive dust is highest during the construction phase (as detailed in Sections 5.2 and 5.6). Unmitigated airborne particulate drift from soil disturbance or herbicide application (or existing herbicide presence in soil) could create a disproportionate health risk for nearby minority and low-income communities (Kasner et al. 2021). Desert crust-bound fungal spores and cyanobacteria may produce mycotoxins and cyanotoxins that, when airborne (e.g., through soil disturbance activities), have been linked to human respiratory distress and systemic chronic illness when inhaled or ingested (Steffan et al. 2018; Powell et al. 2013). Valley fever may put certain groups of people (such as those with weakened immune systems, pregnant women, people with diabetes, and people who are Black or Filipino) at higher risk of infection; valley fever had been common in the southwest region of the United States, but recently has been found as far north as Washington and Utah. Although all populations may be adversely affected by airborne contaminants, minority and low-income populations often bear a disproportional cumulative burden from industrial and/or agricultural-related contaminant exposure.

Additionally, development on or re-disturbance of retired mining sites (e.g., recovery of critical minerals in mining dust) could put communities with EJ concerns at risk of exposure to fugitive dust if sites have not been mitigated to isolate heavy metals, which have been linked to adverse respiratory, cardiovascular, cancerous, and neurological conditions (Entwistle et al. 2019; Zota et al. 2016).

Increased exposure to airborne particulates could exacerbate existing prevalent adverse health conditions (CDC 2023) and disproportionately and adversely impact minority communities located within range of contaminated fugitive dust (Tessum et al. 2021). Cumulative impacts of impaired air quality on local communities with EJ concerns should be considered in determining significance of adverse impact.

5.5.1.1.2 Climate—GHG Emissions

Under the RFDS, if PV development and operation on BLM-administered lands reached approximately 93-GW capacity (by approximately 2045) over the 11-state region planning area, about 123 MMT CO2e/year from fossil fuel power plants could be displaced (EPA 2023j), which would account for about 51% and 11%, respectively, of total emissions from 11-state electric power systems for 2021 and total emissions from 11-state all source categories for 2020 (see Appendix F, Table F.2.3-4). These emissions are equated to 27 million gasoline-powered passenger vehicles off the road for 1 year (EPA 2023k).

Due to complexities of energy markets, solar generation is not necessarily the 1:1 replacement of fossil fuel combustion that was assumed in this analysis, so these estimated emissions would be upper bound values. A reduction of GHG emissions as noted above will potentially mitigate climate-related risks which would assumably benefit communities with EJ concerns who may have less capacity to cope with adverse impacts of extreme climate events. $PM_{2.5}$ may be emitted directly from fossil fuel-fired power plants but are more commonly generated by reactions of precursors, such as NO_x, SO_2, and VOC from fossil fuel-fired power plants along with ammonia in the atmosphere. SO_2 emissions are mostly from coal-fired power plants and minimal from natural gas-fired power plants. Replacing fossil fuel electrical energy production with solar energy production could decrease $PM_{2.5}$ levels, particularly if solar is replacing coal energy production (Wu et al. 2023), which will presumably lend to improved health outcomes for minority and low-income populations who often suffer disproportionately from respiratory and cardiovascular illnesses.

Sulfur hexafluoride (SF_6) is currently used as a common insulator for high-voltage equipment as it is highly stable, effective, and considered non-toxic; 75% of all SF_6 emission in the United States is attributed to electrical transmission and distribution (EPA 2023l). SF_6 is by far the most potent GHG, with a GWP of 23,500; in other words, 1 kg of SF_6 equals the same impact as 23,500 kg of CO_2, and SF_6 has a considerably long atmospheric lifetime of about 3,200 years (EPA 2023l). A recent NOAA study indicated that atmospheric levels of SF_6 are increasing (Hu et al. 2023). Leaks from the electricity distribution systems (including transmission infrastructure that distributes electricity from solar energy facilities) could hinder GHG reduction efforts (Hu et al. 2023; Lan et al. 2022; Widger and Haddad 2018) and thus hinder efforts to mitigate severe climate events and related human health and wellbeing outcomes. Monitoring, proper handling and replacement of old parts can help minimize SF_6 leaks, and as alternative technologies become available, adverse impacts may also be mitigated by replacing SF_6 with climate friendly options.

Although unlikely, an accidental spill of SF_6 could emit a substantial amount of the chemical that could cause potential respiratory distress and skin/eye irritation within 500 m (1/3 mi) of the spill, depending on wind speed and atmospheric stability (NOAA 2023b). In addition, spills during transport of SF_6 along highway or railway routes could put communities with EJ concerns at risk. Exposure to, and adverse impact on, minority and low-income populations would be minimal beyond 1/3 of a mile from major spill, but appropriate precautionary evacuation and treatment measures should be accessible for surrounding communities where cumulative factors, such as pre-existing illnesses, limited access to health care, and limited resources to evacuate safely, may exacerbate health risks. Local health data and public feedback from potentially affected communities with EJ concerns should be considered in determining risk and response.

5.5.1.2 Acoustic Environment (Noise)

Noise pollution can pose a variety of health-related problems for humans, such as "stress related illnesses, high blood pressure, speech interference, hearing loss, sleep disruption, and lost productivity" (Clean Air Act). Human hearing loss can begin to occur at 70 dB (CDC 2022) and the WHO (2010) recommends <30 dB for high-quality sleep. Studies indicate that noise pollution adversely impacts child learning, well-being, and development (Smith et al. 2022; Kannaki et al. 2017).

Site preparation, construction, operation, and decommissioning, as discussed in detail in Section 5.1, will produce low-, mid-, and high-frequency noise that could range from 95 dBA near the construction site to 40 dBA at the distance of 1.2 miles from the site. An acoustics study found that approximately 150 ft from a utility-scale solar inverter, magnetic and electric field levels diminish to background levels well below the limit set for public exposure by the International Commission on Non-Ionizing Radiation Protection (Guldberg 2012).

Nonetheless, communities with EJ concerns are often located near industrial sites and highways where noise levels range between 65 and 90 dB (Walker et al. 2021). Total dB levels from utility-scale solar energy facility construction and operations (from construction/vehicle traffic, etc.) carried over to nearby minority and low-income communities, should be considered with the total impact of cumulative noise from area industry and transportation sources in determining significance of adverse impact. This includes area schools with significant populations of low-income, minority, or children with disabilities, as studies indicate that noise pollution adversely impacts child learning, well-being, and development (Thompson et al. 2022; Kannaki et al. 2017).

5.5.1.3 Water Resources

5.5.1.3.1 General quantity and quality

The CWA of 1972 and the Safe Drinking Water Act of 1974 were implemented to safeguard public health, protect the environment, and provide access to safe and clean water across the country, with special priority to provide safe and adequate access to clean water to communities with EJ concerns (NEJAC 2018).[4] Water use and surface disturbance from utility-scale solar energy facility construction (e.g., mitigating fugitive dust), operation (e.g., cleaning panels), and decommissioning (e.g., mitigating fugitive

[4] For more information about the following topics, see these resources: national drinking water regulations: EPA (2023m); groundwater quality standards: Driscoll et al. (2002); general water quality information: EPA (2023n).

dust) can potentially impair water quality and limit water quantity (see Section 5.7.1), and subsequently impact cultural and subsistence food sources important to minority and low-income populations. Although PV systems require low operational water use (Macknick and Cohen 2015), impact on the quality and quantity of ground and surface water should be considered within the context of significance of impact on minority and low-income communities with limited access to adequate, clean water supplies. Federal and state licensing and permitting processes (see Section 5.7 for details), in addition to mitigation measures outlined in the Design Features section in Appendix B.5, can help monitor and mitigate potentially adverse impacts on water resources upon which EJ communities are dependent.

5.5.1.3.2 Mining Contaminants

EJ is complex and requires a systems perspective to ensure that a comprehensive analysis does not omit impacts from an essential part of implementing a utility scale solar program. PV materials are essential to a utility scale PV solar project. How those materials are procured and how that impacts populations with EJ concerns is relevant to consider at all stages of utility scale PV solar planning and development. Related impacts can be mitigated, to an extent, through sustainable, ethical sourcing practices defined in Design Features (Appendix B.5). Mining activities related to collection and transport of critical elements required for solar PV production could impact the quantity and quality of local water sources through increased water use or runoff and seepage that may contain contaminants at higher than acceptable threshold levels[5]; this could have adverse impacts on humans (EPA 2022a). Recent review of epidemiology studies of rural southwestern and western mountain regions of the United States "demonstrated consistent adverse health outcomes associated with arsenic and Cd exposures among rural, minority populations living in this region" and exposure levels were often higher in rural vs urban setting (Gonzales et al. 2018; Hoover et al. 2019), indicating potential EJ concerns with mining activities related to utility scale PV solar energy development in this region.

Federal and state licensing and permitting processes (see Section 5.7 for details), in addition to mitigation measures outlined in the Design Features section in Appendix B.5, can help monitor and mitigate potentially adverse impacts on water resources upon which EJ communities are dependent.

5.5.1.4 Geology and Soil Resources

Minority and low-income populations living in urban to rural areas can be exposed to soil contaminants through skin absorption, ingestion, and respiration. Soils throughout areas in the western region may contain (through natural or anthropogenic processes) heavy metals, organic chemicals, and pathogens that, when carried as windborne fugitive dust, has been shown to contaminate food sources, playgrounds, and high-

[5] For more information about the following topics, see these resources: national drinking water regulations: EPA (2023m); groundwater quality standards: EPA (2023a,b); general water quality information: EPA (2023n).

contact residential surfaces in nearby minority and low-income communities where EJ is a concern (Entwistle et al. 2019; Zota et al. 2016), thus potentially contributing to disproportionate and adverse impacts.

Studies indicate that PV panels in landfills degrade and may leach harmful minerals into soil, surface, or groundwater sources, thus, with inadequate maintenance or improper decommissioning they could pose potential disproportionate and adverse health risks for minority and low-income communities in proximity to environmental impacts of landfills (Nain and Kumar 2020; Nover et al. 2017; Cyrs et al. 2014). As utility scale PV installations increase to meet national goals, it is important to consider potential impacts of decommissioning PV materials, particularly for communities with EJ concerns, so as to avoid, minimize, or mitigate exposure to leached chemicals from aging and damaged PV components from decommissioned PV materials. Failure to do so could create disproportionate, adverse impacts on EJ communities of concern.

5.5.1.5 Cultural Resources and Loss of Food

Vegetative loss from soil and vegetation displacement, soil compaction, and changes in sunlight or water access (see Section 5.4.1) may affect local populations with EJ concerns who collect specific plants for food, spiritual, or medicinal purposes. Minority, low-income, and Tribal populations could experience diminished access to wild game subsistence resources through vegetation losses and changes in migratory routes.

Loss of access to, or degradation of, physical or visual landscape due to development of utility-scale solar energy facilities could impact the health and well-being of communities with EJ concerns who rely on specific environmental landscapes for physical exercise, social and spiritual connection, or mental restoration (see also Cultural Resources, Section 5.3; Visual Resources, Section 5.19; Recreational Resources, Section 5.14; and Tribal Resources, Section 5.18). As climate change continues to disrupt “normal” environmental patterns through crisis events, positive connections with nature will become increasingly important to restore a sense of physical, spiritual, and emotional balance, particularly for minority and low-income communities that have limited resources to access other natural areas or that integrate nature into their cultural practices and who have meaningful connections with particular lands.

Interactions between vulnerable human communities at risk and target biota or habitats within proposed development sites require integrative assessments of relevant cultural and environmental connections to comprehensively determine the significance of adverse (and beneficial) impact of land use changes (Burger et al. 2022).

5.5.1.6 Socioeconomics

Depending on how a project invests in workforce development and impacts local services, infrastructure, employment options, and housing markets, utility-scale solar projects could benefit as well as adversely impact the socioeconomic stability of communities with EJ concerns in numerous ways (see also Socioeconomics, Section 5.15). Opportunities for employment on a solar project will be limited and hiring will be at the discretion of private developers, but local minority and low-income populations with EJ concerns could potentially benefit, largely short-term, if employment opportunities, including any required education and training, were accessible. However, if employment extends beyond local labor force, higher levels of population in-migration may produce social change such as the strain or breakdown of traditional rural community structures and socio-cultural disruption. Communities with EJ concerns may have inequitable access to adequate health services, housing and transportation options, or financial capacity to buffer negative fluxes in the local market and can be adversely affected by:

- Income inequity between population groups;
- Employment inequity for local workforce and inadequate skills development;
- Diminished efficacy of public services and infrastructures; and
- Instability of in-housing prices, affordability, or occupancy (Caldés and Rodriquez-Serano 2018).

Land use changes may disproportionately and adversely impact the economic stability of low-income rural communities dependent upon the quality of particular environmental features, such as visual aesthetics or access to public grazing areas, if a portion or all such valued lands are partitioned off for the use of a utility-scale solar project. For example, to adequately evaluate the socio-economic ramifications of utility scale solar projects, analysis will need to consider grazing permittees, particularly in the desert southwest where grazing permits are tied to base water, instead of base properties, and year-long grazing occurs. In these areas ranches are predominately if not entirely made up of public land and the amount of acreage needed to develop utility scale solar projects could consume entire ranches. These ranch holders typically have procured loans to purchase these ranches and not allowing them to continue grazing hinders their ability to pay back these loans. These southwestern districts where permits are tied to base water typically have a higher minority and low-income population then other BLM managed districts, which in turn will mean more historically underserved ranchers who could be negatively impacted by the removal of grazing. As the regulations are currently written the only compensation that permittees are provided is fair market value for the loss of range improvements.

5.5.2 Cumulative Impacts

Potential reduction in GHGs and harmful ozone exposure, mitigation of long-term climate shifts, and improved air and water quality may benefit communities with EJ concerns both within and beyond the boundaries of the 11-state planning area. Based on the RFDS, it is expected once solar energy development on BLM-administered lands reaches the RFDS level, up to 123 million MT/year CO_2 equivalent could be displaced by solar energy development, although this is dependent upon reduction of non-renewable (e.g., coal) energy production, transmission, and use as renewable energy becomes available in its place.

Although adverse impacts from utility scale solar energy development may affect any population, when factoring-in the significance of disproportionate adverse impacts, all impacts described in Section 5.5.1 should be considered at the project level and within the context of cumulative health and social issues relevant to affected local minority, low-income, and Tribal communities with EJ concerns.[6] Cumulative factors for populations with EJ concerns are highly dependent on context, but must consider the potential impacts from persistent and/or traumatic exposure to system racism/classism. Historical cumulative factors may include adverse and disproportionate social, health, and economic impacts including the loss of cultural resources, language, and historical lands; forced relocations; and redlining practices and segregated neighborhoods (and subsequent chronic exposure to contaminants, inequitable access to healthy food, health care, safe housing infrastructure, high-quality green spaces, and residential infrastructure improvements, which often create inequitable protection from extreme temperatures and weather events); inequitable funding for schools and educational opportunities; hiring and promotion bias; and non-inclusive or accessible information relevant to making informed decisions and influencing processes and outcomes that reflect the needs and values of those who have experienced systemic barriers to meaningful engagement, etc. Populations with EJ concerns are often inequitably burdened with higher rates of stress and illness, such as high blood pressure, asthma, pulmonary disease, heart disease, and diabetes. Cumulative factors are integral to factoring in how significant utility-scale solar projects might impact a population already contending with adverse and inequitable social, economic, and health burdens.

Overall, broadscale implementation of utility-scale solar in the 11-state region has the potential to impact in myriad ways how EJ concerns are identified and addressed. Physical resources (such as clean air and water), economic factors (such as job opportunities, housing market stability, livestock grazing access) and social opportunities (such as capacity to influence decisions and outcomes) are integrated and often impossible to parse apart with comprehensive analysis. Understanding existing (and historical) conditions that may influence the significance of potential adverse and disproportionate impacts of utility-scale solar energy development will require genuine interest and effort in developing accessible and collaborative processes for meaningful engagement and equitable outcomes.

Additional cumulative project-related adverse impacts on communities with EJ concerns may require considering factors that extend beyond the 11-state planning area. Certain critical minerals are required to develop the materials to collect, store, transport, and use solar energy (lithium, cobalt, nickel, copper manganese, etc.). As the need to transition to renewable energy increases, demand for critical minerals will increase as well. According to the International Energy Agency (IEA), “in a scenario that meets the Paris Agreement goals (as in the IEA Sustainable Development Scenario

[6] “Significance varies with the setting of the proposed action.” Agencies determining level of significance may need to consider, as appropriate: “both short- and long-term effects; both beneficial and adverse effects; effects on public health and safety; effects that would violate Federal, State, Tribal, or local law protecting the environment” (40 CFR Part 1501).

[SDS]), renewable technology's share of total demand rises significantly over the next two decades to over 40% for copper and rare earth elements, 60–70% for nickel and cobalt, and almost 90% for lithium" (IEA 2021b).

Many of these minerals are currently mined outside the United States, which raises the question of sustainability in terms of resource procurement, continuity of energy production and, ultimately, service reliability and affordability (Kowalski and Legendre 2023; IEA 2021b); service reliability and affordability are important considerations for communities with EJ concerns without adequate housing or protection from extreme cold and heat (including those identified in this Programmatic EIS planning area). The current Administration's statement, "Securing a Made in America Supply Chain for Critical Minerals" (White House 2022), highlights strategies to improve energy security and EJ within and beyond U.S. borders, but until resources are secure, communities with EJ concerns within the 11- state planning area may be susceptible to adverse impacts from interrupted services or price increases (a more detailed analysis of access and affordability at the project level could determine the extent to which market fluctuations might impact minority and low-income communities). Communities with EJ concerns that are directly impacted by critical mineral mining may be affected by the socioeconomic impacts listed above as well as through depletion of natural capital (degradation of air, land, and water quality), land use conflicts, health impacts, weakened social cohesion, and limited civic engagement (OECD 2016, 2023).

5.5.3 Design Features and Additional Mitigation Measures

The BLM has identified design features that will be requirements for all utility-scale solar energy projects on BLM-administered lands subject to the ROD for this Programmatic EIS. The list of design features that have been identified to avoid, minimize, and/or compensate for potential impacts on EJ from solar energy development can be found in Appendix B.5.

In addition to the design features, the following mitigation measures may be useful in avoiding, minimizing, and/or mitigating some impacts on EJ:

- The project developer and/or the BLM may provide resources and training, as needed, to facilitate access to relevant environmental and health data (e.g., tutorial help accessing and using the U.S. EPA's EJ Screen (https://www.epa.gov/ejscreen) or other environmental data mapping tools) to increase knowledge of historical and present environmental conditions of the project and surrounding area. In addition to a project developer or BLM using these resources to identify and avoid aggravating existing adverse and/or cumulative conditions, these resources can provide a form of evidential support for local low-income, minority, and/or Tribal populations to advocate for proportional distribution of benefits (e.g., economic) and burdens (e.g., health) related to utility scale solar projects.
- The project developer and/or the BLM may provide accessible, relevant information such as educational materials (developed by third-party neutral

institutions) for use in area schools and local libraries to inform minority, low-income, and Tribal communities on solar energy national goals and how utility scale solar projects work to meet those goals in coordination with other types of renewable energy plans, as well as information specific to utility-scale solar industry and project cycles, and the hazards and benefits of commercial development. General education that encompasses a systems approach to illustrate how utility scale projects work in tandem with other forms of renewable and non-renewable energy to meet national energy needs may improve local understanding and potentially better focus public questions and concerns related to specific projects.

- The project owner/operators and/or the BLM should support monitoring of environmental, social, and economic changes that may be related to project operations and outcomes. For example, this could be done by translating monitoring results for mainstream access; providing monitoring tools and educational resources to support citizen science initiatives; qualitatively analyze public feedback to gauge social response (to understand how concerns are being addressed or how needs and values are being met); supporting community health screenings for low-income, minority, and Tribal people—including periodic screening for contaminant bioaccumulation, air quality monitoring near residential neighborhoods and schools, periodic municipal and groundwater sampling for leached contaminants from critical minerals used in PV installations; etc. This can be done in collaboration with local health professionals, organizations, and local and federal agencies. Finding ways to engage the public in project-related risks and benefits may improve perception of transparency, trust, and engagement, if project managers and/or the BLM are responsive to improving project-related public health outcomes. See Socioeconomic Design Feature section B.5.1.5 for additional ways to monitor and address socioeconomic impact.
- The project owner/operators and the BLM may collaborate with local utilities to ensure equitable access to affordable solar energy for local minority, low-income, and Tribal populations.
- The project owner/operators and the BLM may collaborate with federal agencies, organizations, or communities with EJ concerns on project-related activities that could be initiated to improve local infrastructure, public services, education, and housing.
- Cultural and visual resources that are important to populations with EJ concerns and that may be impacted by utility scale solar energy development and/or decommissioning will need to be identified in collaboration with such affected populations through fair treatment and meaningful engagement processes outlined in CEQ (1997) and BLM (2022d).
- The BLM may follow up with communities with EJ concerns post-project regarding overall processes and outcomes to learn what worked well and what could be done differently in terms of equitable EJ–related processes and outcomes.

5.5.4 Comparison of Alternatives

The following comparison of alternatives includes only Census block group populations that intersect with the lands available for development (e.g., block group populations that intersect or are located within the lands available). This analysis is representative of populations in these block groups and is meant as an initial screening. This does not preclude consideration at the project-implementation level of minority and/or low-income populations residing within surrounding or distant block groups that may be impacted by utility-scale PV solar development.

5.5.4.1 No Action Alternative

Under the No Action Alternative, approximately 47.3 million acres of BLM-administered lands would be available for applications for solar energy development. Of the total BLM-administered lands available for application, 330,195 acres are located within existing priority areas, approximately 15.7 million acres are variance lands allocated in the 2012 Western Solar Plan for the six-state planning area, and approximately 31.6 million acres would be available for application within the five additional states considered in this Programmatic EIS, as these lands were not addressed in the 2012 Western Solar Plan. However, solar energy development is expected to occur only on approximately 700,000 acres (the RFDS value), or 1.4% of BLM-administered lands available for application under the No Action Alternative. Areas available for application under the No Action Alternative contain minority and/or low-income populations, including approximately 1.9 million individuals in low income areas and approximately 900,000 individuals in minority areas (Table 5.5-1). EJ impacts described in Section 5.5.1 could occur from the siting, construction, and operation of PV solar energy facilities under the No Action Alternative. In the six states addressed under the 2012 Western Solar Plan, the design features from that plan would mitigate EJ impacts. In the five new states, required mitigation measures for EJ impacts would be established at the project-specific level.

Table 5.5-1. Minority and Low-Income Populations Residing in Block Group Areas Intersecting with Alternatives

State	Demographic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	No Action Alternative (Variance)
Arizona	Low-Income	119,161	109,958	105,237	98,702	96,012	143,248
	Minority	100,012	90,656	87,263	76,903	76,005	122,141
California	Low-Income	162,185	66,928	53,493	59,498	47,998	192,332
	Minority	103,248	33,169	31,164	30,197	28,192	142,598
Colorado	Low-Income	57,762	42,948	39,656	37,594	34,365	76,921
	Minority	22,337	18,436	15,990	15,747	13,301	30,717
Idaho	Low-Income	88,843	56,144	54,563	54,911	54,105	122,641
	Minority	33,761	27,729	27,729	27,729	27,729	48,372
Montana	Low-Income	40,253	29,200	25,409	28,225	23,986	52,128
	Minority	12,105	9,881	8,156	9,881	8,156	18,569

State	Demographic	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	No Action Alternative (Variance)
Nevada	Low-Income	57,169	50,504	47,920	50,102	47,518	111,927
	Minority	68,577	62,581	60,953	61,676	60,048	213,736
New Mexico	Low-Income	120,058	113,283	103,819	103,536	97,868	151,244
	Minority	165,572	154,503	144,595	139,980	134,999	218,110
Oregon	Low-Income	108,423	56,668	55,015	55,413	53,364	153,866
	Minority	18,844	13,342	13,342	13,014	13,014	31,564
Utah	Low-Income	62,435	49,298	47,331	49,298	46,703	70,010
	Minority	13,615	10,247	10,089	10,247	10,089	18,293
Washington	Low-Income	60,757	25,486	24,381	23,315	22,624	77,562
	Minority	30,432	14,191	14,191	12,602	12,602	33,130
Wyoming	Low-Income	29,741	27,725	26,301	25,884	24,734	38,467
	Minority	12,741	11,719	11,719	11,244	11,244	16,643
Total	Low-Income	1,368,870	964,638	903,079	896,996	848,644	1,940,971
Total	**Minority**	**581,244**	**446,454**	**425,191**	**409,220**	**395,379**	**893,873**

5.5.4.2 Action Alternatives

Alternative 1. Approximately 55 million acres of BLM-administered lands would be available for utility-scale solar application. The RFDS assumes that solar energy development would be limited to approximately 700,000 acres, which is about 1% of the lands available for application under Alternative 1. Alternative 1 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and would also allow more lands available for application than under the No Action Alternative. Areas available for application under Alternative 1 contain minority and/or low-income populations, including approximately 1.4 million individuals in low-income areas and approximately 580,000 individuals in minority areas (Table 5.5-1). The magnitude of EJ impacts would depend on the location of solar energy development and proximity to communities with EJ concerns and relevant resources. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 2. Approximately 36.2 million acres of BLM-administered lands would be available for utility-scale solar application. The RFDS assumes that solar energy development would be limited to approximately 700,000 acres, which is about 2% of the BLM-administered lands available for application under Alternative 2. Alternative 2 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based and a >10% slope exclusion. Areas available for application under Alternative 2 contain minority and/or low-income populations, including approximately 960,000 individuals in low-income areas and approximately 450,000 individuals in minority areas (Table 5.5-1). The magnitude of EJ impacts would depend on the location of solar energy development and proximity to communities with EJ concerns and relevant resources. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 3. Approximately 22.2 million acres of BLM-administered lands would be available for utility-scale solar application. The RFDS assumes that solar energy development would be limited to approximately 700,000 acres, which is about 3% of the BLM-administered lands available for application under Alternative 3. Alternative 3 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a >10% slope exclusion. Alternative 3 would also limit development to areas that are less than 10 miles from existing or planned transmission lines of >100 kV, decreasing the amount of land available for solar energy development. Areas available for application under Alternative 3 contain minority and/or low-income populations, including approximately 900,000 low-income areas and approximately 425,000 individuals in minority areas (Table 5.5-1). The magnitude of EJ impacts would depend on the location of solar energy development and proximity to communities with EJ concerns and relevant resources. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 4. Approximately 11.2 million acres of BLM-administered lands would be available for utility-scale solar application. The RFDS assumes that solar energy development would be limited to approximately 700,000 acres, which is about 6% of the BLM-administered lands available for application under Alternative 4. Alternative 4 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a >10% slope exclusion, and limiting development to previously disturbed lands. Areas available for application under Alternative 4 contain minority and/or low-income populations, including approximately900,000 individuals in low-income areas and approximately 400,000 individuals in minority areas (Table 5.5-1). The magnitude of EJ impacts would depend on the location of solar energy development and proximity to communities with EJ concerns and relevant resources. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 5. Approximately 8.4 million acres of BLM-administered lands would be available for utility-scale solar application. The RFDS assumes that solar energy development would be limited to approximately 700,000 acres, which is about 8% of the BLM-administered lands available for application under Alternative 5. Alternative 5 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a >10% slope exclusion. Alternative 5 would also combine the requirement that development be limited to areas that are less than 10 miles from existing or planned transmission lines of >100 kV (from Alternative 3) with the requirement to limit development to areas with previously disturbed lands (from Alternative 4), making it the alternative with the least lands available for solar ROW application. Alternative 5 provides a focus on areas that may be more likely to be economically feasible for development because the lands available are near the transmission grid and limit the amount of new land disturbance. Areas available for application under Alternative 5 contain minority and/or low-income populations, including approximately 850,000 individuals in low-income areas and approximately 400,000 individuals in minority areas (Table 5.5-1). The magnitude of EJ impacts would depend on the location of solar energy development and proximity to communities with EJ concerns and relevant resources. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Overall, Alternative 5 shows the fewest number of minority and low-income population members impacted. Among the states, New Mexico shows the highest number of minority and low-income population members residing within block groups that intersect with the lands available under the various Alternatives. (Table 5.5-1). Additional analysis in future project-level NEPA reviews should identify at a more granular scale whether populations with EJ concerns are in proximity to (or depend on resources within) the proposed project location and whether development might adversely and disproportionately impact them.

5.6 Geology and Soil Resources

Solar energy development would have a number of impacts on soils in and around project sites, most of which relate to the impacts of ground-disturbing activities. Section 5.6.1 identifies the types of common impacts on soils from solar energy development and the types of geologic hazards that may be encountered. Design features to address soil impacts and geologic hazards are discussed in Section 5.6.2.

5.6.1 Direct and Indirect Impacts

Common impacts from geologic hazards include damage or destruction of infrastructure or entire facilities from the hazards listed in Section 4.6 including seismic ground shaking, ground rupture, slope instability, volcanic hazards, subsidence, and flooding. While the damage, extent, and severity would be specific to a hazardous event, common features of each type of hazard exist for mitigation measures that have been established to minimize losses to projects in these regions, as discussed in Section 5.6.2.

Common impacts on soil resources encompass a range of impacts that would be expected to occur mainly as a result of ground-disturbing activities, especially during the construction phase of a solar energy project, regardless of the type of facility under development. Table 5.6-1 lists the types of potential soil impacts common to all solar energy projects and the project-related activities that could cause them. Common impacts include soil compaction; soil horizon mixing; soil erosion and deposition by wind; soil erosion by water and surface runoff; sedimentation and soil contamination, as described below. Mitigation measures for avoiding or minimizing soil impacts are presented in Section 5.6.2. Implementing mitigation measures to preserve the health and functioning of soils at the project site would reduce the likelihood of soil impacts affecting other resources, such as air, water, vegetation, and wildlife, and would contribute to the success of future reclamation efforts.

Table 5.6-1. Potential Impacts on Soil Resources Common to All Solar Energy Projects

Soil Impact	Impacting Project Activity	Resource Affected by Soil Impact
Soil compaction	• Vegetation clearing and grubbing • Excavation and backfilling • Constructing project structures, ancillary facilities, and infrastructure • Heavy truck and equipment traffic • Increased foot traffic	• Vegetation • Water resources (increased surface runoff; degradation of surface water quality) • Cultural
Soil horizon mixing	• Vegetation clearing and grubbing • Excavation and backfilling • Trenching and backfilling • Drilling and backfilling	• Vegetation • Cultural
Soil erosion and deposition by wind	• Vegetation clearing and grubbing • Excavation and backfilling • Stockpiling soils • Heavy truck and equipment traffic (especially on unpaved roads and surfaces)	• Vegetation • Wildlife • Air quality (fugitive dust) • Water resources (surface water quality) • Cultural
Soil erosion by water and surface runoff	• Vegetation clearing and grubbing • Excavation and backfilling • Stockpiling soils • Constructing road beds • Crossing drainages and wetlands • Heavy truck and equipment traffic	• Vegetation • Wildlife • Water resources (changes in natural flow systems and surface water quality) • Cultural
Sedimentation	• Vegetation clearing and grubbing • Excavation and backfilling • Stockpiling soils • Constructing road beds • Crossing drainages and wetlands • Heavy truck and equipment traffic	• Vegetation • Wildlife • Water resources (surface water quality)
Soil contamination	• Fluid releases related to truck and mechanical equipment use • Accidental releases of hazardous materials • Herbicide applications for weed control • Chemical stabilizer applications for erosion (fugitive dust) control • Toxic metal releases if solar cells were to break during dismantling	• Vegetation • Wildlife • Water resources (surface water and groundwater quality)

Soil compaction. Soil compaction occurs when soil particles are compressed, increasing their density by reducing the pore spaces between them (USDA 2004). It is both an intentional engineering practice that uses mechanical methods to increase the load-bearing capacity of soils underlying roads and site structures and an unintentional consequence of activities occurring in all phases of project development. Unintentional soil compaction is usually caused by vehicular (wheel) traffic on unpaved surfaces but can also result from animal and human foot traffic. Soils are more susceptible to compaction when they are moist or wet. Other factors, such as low organic content and poor aggregate stability, also increase the likelihood that compaction will occur. Soil compaction can directly affect vegetation by inhibiting plant growth because reduced pore spaces restrict the movement of nutrients and plant roots through the soil. Reduced pore spaces can also alter the natural flow of hydrological systems by causing excessive surface runoff, which in turn may increase soil erosion and degrade the quality of nearby surface water. Because soil compaction is difficult to correct once it occurs (USDA 2004), the best mitigation is prevention to the extent possible.

Soil horizon mixing. Soil horizon mixing is another form of soil damage that occurs when construction activities like excavation and backfilling displace topsoil and disturb the existing soil profile. When topsoil is removed, stabilizing matrices (such as biological crusts and desert pavement) are destroyed, increasing the susceptibility of soils to erosion by both wind and water. Such disturbances also directly affect vegetation by disrupting indigenous plant communities and facilitating the growth of invasive plant species. Soil disturbance may also reduce the carbon-fixing function of biological soil crusts and may potentially increase the release of carbon to the atmosphere, especially if large expanses of playa crusts (with caliche) are disturbed.

Soil erosion and deposition by wind. Exposed soils are susceptible to wind erosion. Wind erosion is a natural process in which the sheer force of wind is the dominant eroding agent, resulting in substantial soil loss across much of the exposed area. Wind erosion and deposition are important processes in desert (and other) environments, and their impacts can readily be seen in alluvial valleys as dust clouds and storms and eolian landforms such as yardangs and sand dunes. Solar energy project-related activities such as vegetation clearing, excavating, stockpiling soils, and truck and equipment traffic (especially on unpaved roads and surfaces) can substantially increase the susceptibility of soils to wind erosion. In its soil surveys, the Natural Resources Conservation Service rates the susceptibility of soils to wind erosion based on soil texture, organic matter content, effervescence of carbonates, rock fragment content, and mineralogy (NRCS 2023). The erodibility of soils is also affected by soil moisture, surface cover, soil surface roughness, wind direction and speed, and length of uncovered distance (USDA 2004). Because wind dispersion and deposition of eroded soils can be geographically widespread in some (e.g., desert) environments, this process is an important factor potentially affecting air quality, water quality, vegetation, and wildlife. Indirect impacts on human health (due to soil-borne diseases and/or toxins such as fungal spores) and the water cycle (due to mineral dust deposition on alpine snowpack) are also possible. State and local governments may have specific air permitting requirements regarding the control of fugitive dust and windborne particulates.

Soil erosion by water and surface runoff. Exposed soils are also susceptible to erosion by water, a natural process in which water (in the form of raindrops, ephemeral washes, sheets, and rills) is the dominant eroding agent. The degree of erosion by water is generally determined by the amount and intensity of rainfall but is also affected by the cohesiveness of the soil (which increases with organic content), its capacity for infiltration, vegetation cover, and slope gradient and length (USDA 2004). Activities such as vegetation clearing, excavating, and stockpiling soils substantially increase the susceptibility of soils to runoff and erosion, especially during heavy rainfall events. Surface runoff caused by soil compaction also increases the likelihood of erosion. Soil erosion by surface runoff is an important factor potentially affecting the natural flow of hydrological systems, surface water quality (due to increased sediment loads), and wildlife. State and local governments can be expected to require controls on runoff from solar sites during construction, operation, and decommissioning.

Sedimentation. Soil loss during construction and operations of solar energy facilities (by wind or water erosion) may be a major source of sediment that ultimately makes its way to surface water bodies such as reservoirs, irrigation canals, rivers, lakes, streams, and wetlands. When sediment settles out of water (a process called sedimentation), it can clog drainages and block navigation channels, increasing the need for dredging. By raising streambeds and filling in streamside wetlands, sedimentation increases the probability and severity of floods. Sediment that remains suspended in surface water can degrade water quality, damaging aquatic wildlife habitat and commercial and recreational fisheries. Sediment in water also increases the cost of water treatment for municipal and industrial users (USDA 2004).

Soil contamination. Soil contamination in the project area could result from the general use of trucks and mechanical equipment (fuels, oils, and the like) during all project phases. Facility-specific operations involve the use of hazardous materials such as dielectric fluids and cleaning solvents and would likely generate waste streams such as sanitary wastewater. Improper storage and handling of hazardous materials could result in accidental spills, leaks, and fires (Section 5.20.1). Maintenance-related activities could also contaminate soils in the project area. These activities include the applications of herbicides (for weed control) and chemical stabilizers (for dust control) to the soil surface. Contaminated soil can become a source of contamination for other resources, including vegetation (through uptake), wildlife (through inhalation and ingestion), and water quality (surface water through deposition and groundwater through leaching and infiltration).

Farmland. Areas available for application for utility-scale solar energy development include under each of the alternatives “farmland,” as that term is defined by the Farmland Protection Policy Act (FPPA; 7 U.S.C. 4201(c)(1)) and its implementing regulations (7 CFR 658.2(a)). Utility-scale solar energy development sited on farmland would displace its use for agriculture. Solar development near but not directly sited on farmland could affect the characteristics that qualify the farmland as prime, unique, or of state or local importance (as those concepts are defined by the FPPA).

The programmatic decisions described in this EIS will not cause any utility-scale solar projects to be sited on or in the vicinity of farmland before a project-level decision is also made. Consistent with the FPPA and its implementing regulations, the BLM will identify and take account of the effects on farmland from any application for solar energy development that the BLM would approve, including by considering alternative actions that could lessen any adverse impacts (see 7 CFR 658.4). Where a solar application is proposed on public lands previously classified as farmland, the BLM will coordinate with the NRCS to verify whether the site is subject to the FPPA and to evaluate the impacts of farmland conversion.

5.6.1.1 Site Characterization

Site characterization would involve little or no ground disturbance (Section 3.2.1); therefore, activities during this project phase would result in only small or negligible impacts on soil resources. However, some ground-disturbing activities, such as drilling deep soil cores, installing monitoring wells, clearing, and excavating areas to create surface impoundments for drilling fluids, and building access roads (in remote locations), could occur and result in impacts on soil resources. Direct adverse impacts from these activities relate mainly to the increased potential for soil compaction, soil horizon mixing, soil erosion and deposition by wind, soil erosion by water and surface runoff, and sedimentation of nearby surface water bodies (Table 5.6-1). The degree of impact would depend on the size and design of the project (i.e., the extent of ground-disturbing activities) and on site-specific factors such as soil properties, slope, vegetation cover, weather conditions (i.e., precipitation rate and intensity, prevailing wind direction and speed), and distance to surface water bodies. Implementing good industry practices and mitigation measures (Section 5.6.2) would reduce the level of adverse impacts associated with these activities.

5.6.1.2 Site Preparation and Construction

Construction of a solar energy facility could result in significant impacts on soil resources over an area equivalent to the sum of the footprints of all structures (e.g., solar panels) and related infrastructure (e.g., onsite roads, access roads, parking areas, and fencing; Section 3.2.2). Soil-related impacts during the site preparation and construction phase may extend beyond the site boundary as a result of increased erosion by wind or water. Ground-disturbing activities may include vegetation clearing and grubbing; excavating for foundations, footings, and trenches for buried piping and electrical connections; pile driving (foundations); stockpiling excavated material for backfilling; drilling rock to set foundations and footings; drilling and installing groundwater supply wells; grading for roads, staging and laydown areas, and operations areas; and installing stormwater management features (e.g., ditches and infiltration basins). The construction of other facilities (e.g., support buildings, switchgear facility) would also result in adverse impacts on soil resources from ground disturbance.

Direct adverse impacts of site preparation and construction activities relate mainly to the increased potential for soil compaction, soil horizon mixing, soil erosion and deposition by wind, and soil erosion by water and surface runoff, and sedimentation of nearby surface water bodies (Table 5.6-1). Soil contamination could also result from the release of contaminants related to the use of trucks and mechanical equipment or improper storage and handling, and from the application of chemical stabilizers to control fugitive dust emissions. The degree of impact would depend on the size and design of the project (i.e., the extent of ground-disturbing activities) and on site-specific factors, such as soil properties, slope (e.g., along gullies and on alluvial fan surfaces), vegetation, weather, and distance to surface water. Implementing good industry practices and mitigation measures (Section 5.6.2) would reduce the level of adverse impacts associated with these activities.

5.6.1.3 Operations and Maintenance

Direct adverse impacts of operations and maintenance are expected to be small, because project activities (e.g., monitoring controls and inspecting equipment, maintenance, and panel washing) would not involve extensive ground disturbances (beyond that which has already occurred during construction) that increase the potential for soil compaction, soil horizon mixing, soil erosion and deposition by wind, soil erosion by water and surface runoff, and sedimentation of nearby surface water bodies (Section 3.2.4). Soil erosion could still occur during the operations phase, however, if soil surfaces exposed by vegetation clearing, grading, and excavation during the site preparation and construction phase continue to be exposed during the life of the project. The risk of erosion would be greatest when exposed soils are subjected to high wind conditions or intense rainfall and surface runoff along roads is channeled into natural drainages. Soil compaction could also occur but would not be substantial because most routine vehicle traffic would be limited to paved or graveled roads. Soil contamination could result from the release of contaminants related to the use of trucks and mechanical equipment or improper storage and handling and through the sustained applications of herbicides and chemical stabilizers to control vegetation and fugitive dust emissions. Implementing good industry practices and mitigation measures (Section 5.6.2) would reduce the level of adverse impacts associated with these activities.

5.6.1.4 Decommissioning/Reclamation

Project activities during the decommissioning phase (including reclamation) could result in significant impacts on soil resources because they would involve ground disturbances that increase the potential for soil compaction, soil horizon mixing, soil erosion and deposition by wind, soil erosion by water and surface runoff, and sedimentation of nearby surface water bodies. Ground-disturbing activities would include removal of most if not all equipment, removal of permanent structures and improvements (including onsite and access roads), and closure of onsite wells (Section 3.2.5). Direct adverse impacts would be smaller than during construction, because the objective of this project phase is to return the site to its native condition (e.g., by re-establishing native vegetative communities) and the use of existing access roads would reduce impacts such as compaction and erosion (e.g., fugitive dust generation). However, reestablishing vegetation in some environments (e.g., desert) may require substantial time, and soils could remain susceptible to erosion throughout reclamation activities and beyond, especially if subjected to high wind conditions or intense rainfall. Soil contamination is less likely during this phase but could result from fuel and oil releases related to the use of trucks and mechanical equipment and toxic metal releases if solar cells are broken during facility dismantling. Implementing good industry practices and mitigation measures (Section 5.6.2) would reduce the level of adverse impacts associated with these activities.

5.6.1.5 Transmission Lines and Roads

The construction of transmission lines within designated ROWs to connect new solar energy projects to regional utilities would result in soil impacts over an area equivalent to the sum of the footprint areas for all the tower foundations, access roads, and staging and laydown areas. Transmission line upgrades could also result in substantial soil disturbance. Construction would involve ground-disturbing activities such as vegetation clearing and grubbing; excavating for foundations and footings; stockpiling excavated material for backfilling; drilling rock to set foundations and footings; and grading for access roads and staging and laydown areas (Section 3.2.6). Direct adverse impacts of these activities relate mainly to the increased potential for soil compaction, soil erosion by water and surface runoff, and sedimentation of nearby surface water bodies. The degree of impact would also depend on site-specific factors, such as soil properties, slope (e.g., along gullies and on alluvial fan surfaces), vegetation, weather, and distance to surface water. Some disturbed areas (e.g., assembly and laydown areas and temporary roads) would be reclaimed at the end of the construction period. Implementing good industry practices and mitigation measures (Section 5.6.2) would reduce the level of adverse impacts associated with these activities.

Direct adverse impacts of operations are expected to be small because activities would mainly entail periodic inspections and maintenance that would not increase the potential for soil compaction, soil erosion by water and surface runoff, or sedimentation of nearby surface water bodies. Soil erosion could still occur, however, on exposed surfaces under high wind conditions or intense rainfall and along roads as surface runoff is channeled into natural drainages. Soil compaction could also occur but would not be significant because most routine vehicle traffic would be limited to paved or graveled roads. Implementing good industry practices and mitigation measures (Section 5.6.2) would reduce the level of adverse impacts associated with these activities.

Decommissioning of transmission lines would involve ground-disturbing activities (e.g., removal of all equipment and permanent structures and remediation of all spills or leaks of chemicals) that could increase the potential for soil compaction, soil erosion by water and surface runoff, and sedimentation of nearby surface water bodies. Impacts would be smaller than during site preparation and construction, because the objective of this project phase is to return the site to its native condition (e.g., by re-establishing native vegetative communities) and the use of existing access roads would reduce impacts such as compaction and erosion (e.g., fugitive dust generation). Implementing good industry practices and mitigation measures (Section 5.6.2) would also reduce the level of adverse impacts associated with these activities.

5.6.2 Cumulative Impacts

Under the RFDS, the BLM estimates that a total combined area of approximately 700,000 acres of BLM-administered lands and 600,000 acres of other lands (including private lands and state-owned lands) across the 11-state planning area will host utility-scale PV solar energy development over the next 20 years. The primary concern for geologic and soil resources from solar energy development is the large acreages that could be disturbed for the construction of utility-scale facilities. Although the new design features to be implemented through this Solar Programmatic EIS require that vegetation in solar fields would be left in place during the construction of PV solar energy facilities, some grading and excavation would still occur for support structures. Additionally, use of construction vehicles would potentially result in soil compaction, erosion (especially if vegetation is destroyed), and contamination from fuel leaks. While soil erosion design features would be in place, some soil loss would be unavoidable, given the large acreages disturbed, and dry soil/high wind conditions in some parts of the planning area. Solar energy development would be a major contributor to cumulative impacts on soil from foreseeable development in the 11-state region. Other foreseeable actions that would contribute to soil erosion are road construction, including that associated with solar and other renewable energy development, transmission and pipelines, mining, and agriculture. Overall foreseeable cumulative impacts on soil from PV solar energy development on BLM-administered lands, in conjunction with impacts from other activities in the planning area, would be small to moderate assuming appropriate design features are in place and given the relatively small fraction of total land area potentially affected by all activities.

5.6.3 Design Features

The BLM has identified design features that will be requirements for all utility-scale solar energy projects on BLM-administered lands subject to the ROD for this Programmatic EIS. The list of design features that have been identified to avoid, minimize, and/or compensate for potential impacts on geologic and soil resources from solar energy development can be found in Appendix B.6.

5.6.4 Comparison of Alternatives

Development of large blocks of land for solar energy facilities and related infrastructure results in impacts on geologic and soil resources in terms of soil compaction and erosion. Although these impacts can be effectively mitigated, the potential for soil erosion increases with development on steeper slopes and the alternatives are compared on this basis. Impacts on biological soil crusts should be avoided by compliance with existing design features. Solar development on productive or potentially productive farmland would likely preclude agricultural use of that land. About

18.2 million acres of BLM-administered land in the 11-state planning area has a farmland classification, including lands in each state (Table 5.6.4-1). A quantitative comparison of land having a farmland classification was analyzed across all alternatives. The fraction of available land that is farmland was used as a basis for comparison of alternatives. In addition, the area of land developed under the RFDS as a fraction of the available non-farmland for each alternative was used as a measure of the relative ability to avoid farmland impacts.

Table 5.6.4-1. Lands Having a Farmland Classification – BLM-Administered Lands in the 11-State Planning Area[a]

State	BLM-admiistered Lands (Minus DRECP/ CDCA)	BLM-Administered Lands Having a Farmland Classification	
		Acres	Percent
Arizona	12,109,337	207,630	1.7
California	4,150,345	161,573	3.9
Colorado	8,354,306	419,661	5.0
Idaho	11,774,992	2,338,091	19.9
Montana	8,043,025	493,116	6.1
Nevada	47,272,125	4,711,462	10.0
New Mexico	13,493,392	467,330	3.5
Oregon	15,718,197	7,234,664	46.0
Utah	22,767,896	1,219,394	5.4
Washington	437,237	78,102	17.9
Wyoming	18,047,498	916,561	5.1

[a] Land with a farmland classification identified from USDA (2021). Includes land areas classified as prime farmland (including conditional classifications, such as prime farmland if irrigated), farmland of statewide importance (including conditional classifications, such as farmland of statewide importance if irrigated), farmland of local importance, and farmland of unique importance.

5.6.4.1 No Action Alternative

Under the No Action Alternative, approximately 47.3 million acres of BLM-administered lands would be available for applications for solar energy development. Of the total lands available for application, 330,195 acres are located within existing priority areas, approximately 15.7 million acres are variance lands allocated in the 2012 Western Solar Plan for the six-state planning area, and approximately 31.6 million acres would be available for application within the five additional states considered in this Programmatic EIS, as these lands were not addressed in the 2012 Western Solar Plan. Exclusion of development on slopes greater than 5 percent (for the six states in the 2012 Western Solar Plan) decreases the potential for erosion of disturbed soils. Any development on slopes greater than 5% in the five states not addressed in the 2012 Western Solar Plan) would increase the potential for erosion of disturbed soils. In the six states addressed under the Western Solar Plan, the design features from that plan would mitigate geologic and soil resources/impacts. In the five new states, required mitigation measures for geologic and soil resources impacts would be established at the project-specific level.

Approximately 27,000 acres (8.1%) of priority areas in the 2012 Western Solar Plan for the six-state planning area have a farmland classification (Table 5.6.4-2). Of the total available lands in the 11-state planning area (these are variance lands in the six states addressed in the Western Solar Plan), about 8.4 million acres (17.7%) have a farmland classification. Solar development on these areas would reduce the availability of productive or potentially productive farmland. Under the RFDS, of the lands available for application, the BLM estimates that approximately 700,000 acres (1.4%) will host utility-scale PV solar energy development over the next 20 years. This total projected area of development is a small fraction (1.8%) of the total available lands in the 11-state planning area not having a farmland classification, indicating that there are ample non-farmlands available for development.

5.6.4.2 Action Alternatives

The Action Alternatives would help the BLM meet its energy goals through resource-based exclusion criteria that focus development into areas avoiding resource conflicts. The resource-based exclusion criteria, described in Chapter 2, are applicable to each of the Action Alternatives, and include criteria that are likely related to the presence of valuable soil resources. For example, areas supporting critical habitat and terrestrial species may be correlated with the presence of well-developed soils. However, the resource-based exclusion criteria applied to the Action Alternatives do not include any criteria specifically addressing potential soil resources impacts.

Soil resources could be affected by solar energy development ROW authorizations under each of the alternatives. The magnitude of the impacts on soil resources from development to the RFDS level on BLM-administered lands would depend on the location of solar energy development within the available area and the specific soil resources affected. Under each alternative there would likely be siting options to avoid the most critical soil resources (and geologic hazards) present in the areas of BLM-administered lands available for solar energy development. The options to avoid impacts on soil resources would be limited if the soil characteristics associated with impacts (e.g., the presence of well-developed biological soil crusts, highly erodible soils, or soils with farmland classification) comprised a substantial fraction of the area available for development.

5.6.4-2. BLM-Administered Lands Having a Farmland Classification – Comparison Across Alternatives[a]

State	No Action Alternative: Intersection of farmland with Priority Areas[b] (acres)		No Action Alternative: Intersection of farmland with lands available for application (variance lands in six-state area)		Alternative 1: Intersection of farmland with lands available for application		Alternative 2: Intersection of farmland with lands available for application		Alternative 3: Intersection of farmland with lands available for application		Alternative 4: Intersection of farmland with lands available for application		Alternative 5: Intersection of farmland with lands available for application	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
Arizona	8,868	4.5	68,446	2.4	72,759	1.5	71,720	2.2	54,766	2.4	44,320	5.0	36,527	5.0
California	-	-	9,815	8.3	32,327	2.8	24,674	11.2	21,866	13.9	20,844	17.9	18,642	20.9
Colorado	902	4.1	19,570	14.4	140,511	6.2	93,040	11.4	64,911	11.8	42,438	12.9	32,236	13.7
Idaho	-	-	1,596,695	22.6	644,363	24.3	615,514	33.5	480,156	32.6	327,398	34.7	303,437	35.0
Montana	-	-	318,189	7.9	111,327	9.1	96,342	13.5	29,315	14.0	79,199	15.4	23,665	15.8
Nevada	16,986	27.5	1,021,638	14.9	2,143,146	11.7	2,086,679	16.9	1,151,839	16.5	764,073	31.5	460,776	29.0
New Mexico	-	-	151,035	3.9	200,063	3.2	191,797	3.8	120,135	4.0	106,361	6.0	63,059	4.8
Oregon	-	-	4,624,865	42.2	795,166	31.1	524,471	46.6	324,939	45.4	213,693	52.4	149,268	48.4
Utah	100	0.6	58,373	3.2	645,849	6.5	583,336	8.9	311,917	8.3	221,965	11.5	150,898	9.6
Washington	-	-	74,900	18.2	67,337	19.0	34,128	27.3	29,947	28.1	26,356	27.8	23,413	28.8
Wyoming	-	-	417,576	4.6	300,049	5.5	257,554	6.2	195,039	6.5	120,646	6.8	101,122	7.0
Westwide	26,855	8.1	8,361,104	17.7	5,152,897	9.4	4,579,253	12.7	2,784,831	12.5	1,967,294	17.6	1,363,043	16.3

[a] Land with a farmland classification identified from USDA (2021). Includes land areas classified as prime farmland (including conditional classifications, such as prime farmland if irrigated), farmland of statewide importance (including conditional classifications, such as farmland of statewide importance if irrigated), farmland of local importance, and farmland of unique importance.

[b] Includes SEZs (Solar Energy Zones) as amended, solar emphasis areas (BLM 2015), and the Dry Lake East DLA (BLM 2022). The total priority area in each state has been updated to reflect changes implemented since 2012 (see Section 1.3).

Alternative 1. Approximately 55 million acres of BLM-administered lands would be available for utility-scale solar ROW application, which constitutes all BLM-administered lands not excluded through resource-based exclusion criteria. Approximately 5.2 million acres (9.4%) of the available lands under Alternative 1 have a farmland classification (Table 5.6.4-2). The fraction of available land having a farmland classification varies from 1.5% in Arizona to 31.1% in Oregon. Alternative 1 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria, while making all other lands available for application. Alternative 1 would make more lands available for application than are currently available under the No Action Alternative. The RFDS estimates that solar energy development would only occur on approximately 700,000 acres, which would be about 1% of the land available under Alternative 1 for solar ROW application and about 1.4% of the available land without a farmland classification, indicating that there are ample non-farmlands available for development. Alternative 1 has no slope-based exclusion and would allow development on slopes greater than 10%. This would increase the potential for erosion of disturbed soils, as compared to the No Action Alternative and the other Action Alternatives. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 2. Approximately 36.2 million acres of BLM-administered lands would be available for utility-scale solar ROW application. In addition to the resource-based exclusions, all BLM-administered lands with a slope greater than 10% would be excluded from solar energy development. Restricting development on the steeper slopes would reduce the potential for soil erosion impacts, as compared to those of Alternative 1. In the six states addressed under the Western Solar Plan, Alternative 2 would increase the potential for soil erosion impacts, as compared to the No Action Alternative, because BLM-administered lands with a slope greater than 5% would be available for solar energy development. Approximately 4.6 million acres (12.7%) of the lands available for development under Alternative 2 have a farmland classification, an increase compared to Alternative 1 (Table 5.6.4-2). The fraction of available land having a farmland classification varies from 2.2% in Arizona to 46.6% in Oregon. The RFDS estimates that solar energy development would occur on approximately 700,000 acres, which would be about 2% of the lands available under Alternative 2 and about 2.2% of the available lands without a farmland classification, indicating that there are ample non-farmlands available for development. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 3. Approximately 22.2 million acres of BLM-administered lands would be available for utility-scale solar ROW application. In addition to the resource-based exclusions and the exclusion of all lands with a slope greater than 10%, Alternative 3 would limit solar energy development to BLM-administered lands less than 10 miles from a transmission line of 100 kV or greater. Restricting development to lands within

10 miles of a transmission line would focus development in areas that are likely to be more economically feasible. This alternative would have an indeterminate impact on soil resources (compared to Alternative 2) for the development area covered by solar panels and associated facilities. However, the soil disturbance associated with transmission line development would potentially be reduced, as compared to Alternative 2, if fewer miles of connecting transmission line development occur under Alternative 3 due to the exclusion of lands > 10 miles from existing or planned transmission lines. Approximately 2.8 million acres (12.5%) of the lands available for development under Alternative 3 have a farmland classification (Table 5.6.4-2), the same fraction as for Alternative 2. The fraction of available land having a farmland classification varies from 2.4% in Arizona to 45.4% in Oregon. The RFDS estimates that solar energy development would occur on approximately 700,000 acres, which would be about 3% of the lands available for solar ROW application under Alternative 3 and about 3.6% of the available lands without a farmland classification, indicating that there are likely ample non-farmlands available for development. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 4. Approximately 11.2 million acres of BLM-administered lands would be available for utility-scale solar ROW application. In addition to the resource-based exclusions and the exclusion of all BLM-administered lands with a slope greater than 10%, Alternative 4 would limit development to previously disturbed lands. This would likely drive solar energy development to areas where current and past development is more prevalent. This would likely reduce the potential for impacts on this critical soil resource, as compared to Alternatives 2 and 3. Approximately 2 million acres (17.6%) of the lands available for development under Alternative 4 have a farmland classification (Table 5.6.4-2), indicating that development on potentially productive farmland could occur under Alternative 4. The fraction of available land having a farmland classification varies from 5% in Arizona to 52.4% in Oregon. The RFDS estimates that solar energy development would occur on approximately 700,000 acres, which would be about 6% of the lands available for solar ROW application under Alternative 4 and about 7.6% of the available lands without a farmland classification. This alternative could increase impacts to productive or potentially productive farmland compared to Alternatives 1,2, and 3. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 5. Approximately 8.4 million acres of BLM-administered lands would be available for utility-scale solar ROW application. In addition to the resource-based exclusions and the exclusion of all lands with a slope greater than 10%, Alternative 5 would limit development to BLM-administered lands within 10 miles of a transmission line of 100 kV or greater and previously disturbed. This would focus solar energy development in areas that are likely to be more economically feasible and where current and past development is more prevalent. Under Alternative 5, the soil disturbance associated with transmission line development would potentially be reduced, as compared to Alternative 4 (and Alternatives 1 and 2), if fewer miles of connecting transmission line development would occur due to the exclusion of lands greater than 10 miles from existing and planned transmission lines. Approximately 1.4 million acres (16.3%) of the lands available for development under Alternative 5 have a farmland classification (Table 5.6.4-2), indicating that development on potentially productive farmland could occur under Alternative 5. The fraction of available land having a farmland classification varies from 5% in Arizona to 48.4% in Oregon. The RFDS estimates that solar energy development would occur on approximately 700,000 acres, which would be about 8% of the lands available for solar ROW application under Alternative 5 and about 10% of the available lands without a farmland classification. This alternative could increase impacts to productive or potentially productive farmland compared to the other Alternatives. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

5.7 Hazardous Materials and Waste

Section 4.7 provides a discussion of the amounts and types of hazardous materials that would be present at a solar energy facility during its construction, operation, and decommissioning phases. Wastes expected to be generated during those phases and the likely management and disposal strategies that would be employed are also discussed. The following sections discuss the possible adverse impacts resulting from the presence and use of hazardous materials and the generation, management, and disposal of wastes.

5.7.1 Direct and Indirect Impacts

5.7.1.1 Construction

The array of hazardous materials used in solar energy facility construction is similar to those used in the construction of any industrial facility. Likewise, the wastes expected to be generated are common to such construction projects, and various mitigation measures exist for their safe management and disposal. Impacts from the hazardous materials present during construction include increased risks of fires and contamination of environmental media from improper storage and handling, leading to spills or leaks. However, there is considerable solar industry experience in the use of such hazardous materials to support construction, and the industry has established appropriate management practices, worker training, personal protective equipment (PPE), and contingency planning to address such potentially adverse impacts.

Construction-related wastes include various fluids from the onsite maintenance of construction vehicles and equipment (used lubricating oils, hydraulic fluids, glycol-based coolants, and spent lead-acid storage batteries); incidental chemical wastes from the maintenance of equipment and the application of corrosion-control protective coatings (solvents, paints, and coatings); construction-related debris (e.g., dimension lumber, stone, and brick); and dunnage and packaging materials (primarily wood and paper). All such materials are expected to be initially accumulated onsite and ultimately disposed of or recycled through offsite facilities. Some construction-related waste (e.g., spent solvents and corrosion control coatings applied in the field) may qualify as characteristic hazardous waste or state- or federal-listed hazardous waste. Short-term accumulation and storage of hazardous waste onsite would be subject to the generator regulations in 40 CFR Part 261 promulgated under the authority of the Resource Conservation and Recovery Act (RCRA). However, any hazardous waste is likely to be transported to offsite RCRA-permitted treatment, storage, and disposal facilities prior to the time when the RCRA regulations would require a permit for their onsite management.

Potential impacts from the generation of such wastes include potential contamination of environmental media from improper collection, containerization, storage, and disposal. As with hazardous materials, appropriate waste management strategies—supported by the availability of appropriate waste containers and properly designed storage areas and implemented by worker training and adherence to established and disseminated waste management policies and appropriate in-house spill response capabilities—can be expected to successfully avert adverse impacts while the wastes are being accumulated onsite and during delivery to offsite disposal or recycling facilities.[6]

5.7.1.2 Operations and Maintenance

Solar energy facilities can be expected to have substantial quantities of dielectric fluids contained in various electrical devices such as switches, transformers, and capacitors as well as several types of common industrial cleaning agents. Solar energy facilities also can be expected to engage in some degree of noxious weed and vegetation management that would result in approved and registered herbicides being applied on the site and some wastes generated as a result of such activities. Solar energy facilities can be expected to have a relatively small complement of hazardous materials present to support equipment cleaning, repair, and maintenance.

Wastes common to solar energy facilities include (1) domestic solid wastes and sanitary wastewaters from workforce support and (2) industrial solid and liquid wastes resulting from routine cleaning and equipment maintenance and repair. Volumes of domestic solid wastes and sanitary wastewaters would be limited and proportional to the expected relatively small size of the operating workforce. Various options would be available for the management and disposal of domestic solid waste and sanitary waste. In all instances, solid wastes can be expected to be accumulated onsite for short periods until they are delivered to permitted offsite disposal facilities, typically by commercial waste disposal services. Options for sanitary wastewaters range from onsite disposal in septic systems, when circumstances allow, to offsite treatment and disposal in publicly owned treatment works. All such treatment or disposal options,

[6] Because of the expected remoteness of some facilities, responses by external resources may not be immediate and in-house spill/emergency response capabilities sufficient to stabilize the upset condition are considered essential.

properly implemented, would preclude adverse environmental impacts. Some industrial wastes (e.g., spent cleaning solvents) may exhibit hazardous character, but well-established procedures for the management, disposal, and/or recycling of all industrial wastes should be readily available and would keep adverse impacts to a minimum. Wastes from herbicide applications would likely include empty containers and possibly some herbicide rinsates.[7]

Unless major malfunctions occur, dielectric fluids can be expected to remain in their devices throughout the active life of the facility, and no dielectric wastes are expected except as a result of unplanned spills or leaks. Adverse impacts would include potential worker exposure to hazardous materials and wastes and contamination of environmental media resulting from spills or leaks of hazardous materials or from improper waste management techniques. Well-developed management programs involving proper facility design, worker training, PPE, well-developed and well-understood management strategies, and appropriate spill contingency plans can be expected to largely preempt adverse impacts.

Only a small array of hazardous materials would be used to support the operation of a solar PV facility. Under normal operating circumstances, no unique hazardous materials or waste impacts other than those discussed in Section 5.7.1.2 are anticipated. As discussed more fully in Section 5.21, high-performance solar cell materials contain small amounts of toxic metals such as Cd, selenium, and arsenic. Under normal conditions, these metals are secured within sealed solar panels and represent no hazard to workers or the public. However, damaged solar cells may create worker exposure and may require special handling during facility decommissioning.

5.7.1.3 Decommissioning/Reclamation

During decommissioning, virtually the identical complement of hazardous materials would be present to support vehicles and equipment as was present during facility construction. However, the decommissioning period would likely be shorter than that of initial construction.

Wastes generated during decommissioning would largely be derived from the maintenance of vehicles and equipment and would be managed in very much the same manner as during construction, with the same potential for adverse impacts. Impacts during facility dismantlement and draining would include spills and leaks and releases to the environment from improper temporary onsite storage of recovered fluids. Some materials would need to be managed as solid waste (e.g., broken concrete and masonry from onsite buildings and foundations); however, much of the material produced (e.g.,

[7] Pesticide application is likely to be a contracted service. Typically, pesticide contractors will be responsible for removing any wastes from the operation to offsite treatment or disposal facilities. Use of proper techniques in developing field-strength solutions from pesticide concentrates typically results in a triple-rinsed container that can be disposed of as solid waste and rinsates that will have been incorporated into the solution to be applied. Application equipment is typically cleaned at the contractor’s offsite location.

steel and aluminum infrastructures, power cables) is likely to be recyclable after short-term onsite storage.[8]

At present, the most common type of PV panel is made using crystalline-silicon (c-SI). This technology accounts for 84% of U.S. solar panels (EPA 2023o). By weight, the typical crystalline silicon solar panel is made of about 76% glass, 10% plastic polymer, 8% aluminum, 5% silicon, 1% copper, and less than 0.1% silver and other metals, (Dominish et al. 2019). The quantity of each material (in pounds) for a single 50-lb. PV panel is shown in Table 5.7-1.

Table 5.7.1. Composition of a Typical Photovoltaic Solar Panel

Material	Percentage	Weight (lb.)	
Glass	76	38	
Plastic polymer	10	5	
Aluminum	8	4	
Silicon	5	2.5	
Copper	1	0.5	
Other metals	<0.1	<0.5	

Many of the components of a PV solar panel, including the glass, metal frame, copper wire, and plastic parts can be easily recycled. Other materials, such as silver, tin, tellurium, antimony, gallium, and indium are recyclable, but the process is more challenging. Assuming the glass, plastic polymer, aluminum, and copper is recycled upon decommissioning, and none of the other metals are recycled, only about 3 lb. of waste would be generated for each PV panel discarded. Some of this could however, be hazardous waste.

Assuming, on average, 7.5 acres of land is required to generate one MW of power (see Chapter 3) and assuming a generation capacity of 350-400 watts per panel, between 2,500 and 4,000 PV panels would be required per acre. This equates to between 7,500 and 12,000 lb. of waste per acre upon decommissioning (after recycling), including 1,250 to 2,000 lb. of heavy metals per acre for c-SI panels.

Because the metals involved are relatively rare in commerce, efforts have been undertaken to create recycling opportunities for damaged or decommissioned high-performance solar panels; however, given the relative newness of this aspect of the PV solar energy industry, it is not possible to affirm with certainty that such recycling opportunities would materialize or be available at the time current facilities are decommissioned.[9] Absent legitimate recycling opportunities, damaged or

8 Given the volumes of materials produced during facility dismantlement, it is possible that laydown areas used during initial construction would be re-established as temporary storage areas for materials awaiting delivery to recycling areas. Waste materials would ideally be stored in areas used for hazardous materials and waste storage during facility operation before being transported to offsite treatment, storage, or disposal facilities.

9 Current incentives for PV panel recycling are the result of the relative rarity and expense of the toxic metals currently used in high-performance PV panels. However, should PV technology evolve to the use

decommissioned solar panels containing toxic metals would need to be characterized and might need to be managed as hazardous waste.

5.7.2 Cumulative Impacts

Only a small array of hazardous materials would be used to support the operation of a single PV solar energy facility. Under the RFDS, the BLM estimates that a total combined area of approximately 700,000 acres of BLM-administered lands will host utility-scale PV solar energy development over the next 20 years. During construction of solar energy facilities, hazardous materials used are expected to be similar to hazardous materials used in the construction of any industrial facility. Additional hazardous materials required for other foreseeable development such as oil and gas production, mining, and the construction of wind and geothermal energy facilities, could have a cumulative impact. Similar cumulative impacts would be expected during operations.

As described in Section 5.7.1.3, decommissioning of solar energy facilities would generate approximately 7,500 to 12,000 lb. of waste per acre (after recycling), including 1,250 to 2,000 lb. of heavy metals per acre for c-SI panels. Based on the 700,000 acres of BLM-administered lands and 600,000 acres of other lands (including private lands and state-owned lands) across the 11-state planning area that that the BLM estimates will host utility-scale solar energy development over the next 20 years under the RFDS, between 2.4 and 3.8 million tonnes of waste could be generated from solar facilities located on BLM-administered lands, which includes between 400,000 and 600,000 tonnes of potentially hazardous waste from heavy metals for c-SI panels.

Waste generated from solar energy facility decommissioning would add to waste generated from other industrial uses. Waste generated from decommissioning a solar energy facility would generally be on par with that generated from decommissioning of a natural gas-fired power-plant, in terms of the metal, glass, concrete, and other components of the infrastructure. In the case of coal-fired and nuclear power plants, the infrastructure wastes would also be similar in nature, but the former may generate substantial quantities of fly-ash, and the latter would generate high and low-level nuclear waste on-site that would require disposition upon decommissioning.

Successful implementation of design features will reduce the risk of issues with the storage, use, and disposition of wastes and hazardous materials.

5.7.3 Design Features

The BLM has identified design features that will be requirements for all utility-scale solar energy projects on BLM-administered lands subject to the ROD for this Programmatic EIS. The list of design features that have been identified to avoid,

of other materials in high-performance PV cells, the recycling value of current-day PV panels would be significantly reduced (at least as a source of refabricated PV panels), and such technological evolutions could be a disincentive to the emerging PV recycling market.

minimize, and/or compensate for potential hazardous materials and waste impacts from solar energy development can be found in Appendix B.7.

5.7.4 Comparison of Alternatives

5.7.4.1 No Action Alternative

Under the No Action Alternative, approximately 47.3 million acres of BLM-administered lands would be available for applications for solar energy development. Of the total lands available for application, 330,195 acres are located within existing priority areas, approximately 15.7 million acres are variance lands allocated in the 2012 Western Solar Plan for the six-state planning area, and approximately 31.6 million acres would be available for application within the five additional states considered in this Programmatic EIS, as these lands were not addressed in the 2012 Western Solar Plan. Of the open available lands, under the RFDS the BLM estimates that approximately 700,000 acres (1.4%) of BLM-administered lands will host utility-scale PV solar energy development over the next 20 years. Hazardous materials and waste described in Section 5.7.1 could be generated from the construction and decommissioning of PV solar energy facilities under the No Action Alternative. In the six states addressed under the 2012 Western Solar Plan, the design features from that plan would mitigate impacts from hazardous materials and wastes. In the five new states, required mitigation measures for impacts from hazardous materials and wastes would be established at the project-specific level.

5.7.4.2 Action Alternatives

Alternative 1. Approximately 55 million acres of BLM-administered lands would be available for utility-scale ROW application.

Alternative 2. Approximately 36.2 million acres of BLM-administered lands would be available for utility-scale solar energy applications.

Alternative 3. Approximately 22.2 million acres of BLM-administered lands would be available for utility-scale ROW application.

Alternative 4. Approximately 11.2 million acres of BLM-administered lands would be available for utility-scale solar energy applications.

Alternative 5. Approximately 8.4 million acres of BLM-administered lands would be available for utility-scale solar energy applications.

The RFDS estimates that solar energy development would occur on only 700,000 acres within BLM-administered lands available under Alternatives 1 through 5. Hazardous materials and waste described in Section 5.7.1 would be generated from the construction, operation, and decommissioning of PV solar energy facilities under the Action Alternatives. The impacts from hazardous materials and wastes from development to the RFDS level on BLM-administered lands within the planning area would be similar under all of the Action Alternatives, since the generation of waste is generally independent from the geographic location of the development. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

5.8 Health and Safety

PV solar energy development could produce occupational health impacts on workers and environmental health concerns in the area around the facilities. Such impacts and concerns would result from the construction and operation of the primary and supporting solar energy facilities, including transmission lines. The following subsections discuss the types of impacts on human health and safety that could occur from PV solar energy development.

5.8.1 Direct and Indirect Impacts

5.8.1.1 Occupational Health and Safety

Occupational health and safety considerations related to typical solar energy projects include physical hazards; risks of injuries and/or fatalities to workers during construction and operation of facilities and associated transmission lines; risks resulting from exposure to weather extremes (e.g., occupational heat stress or stroke, frostbite); risk of harmful interactions with plants and animals; fire hazards; risks associated with retinal exposures to high levels of glare; risks associated with dust from construction activities; a small risk of exposures to hazardous substances used at or emitted from the facilities; risk of electrical shock; and the possibility of increased cancer risk if exposure to magnetic fields of exceptionally high strengths were to occur. Table 5.8-1 enumerates the major occupational health and safety issues related to activities at PV solar energy facilities and associated transmission systems. Potential control measures for these health and safety issues are also given, including recommendations for the creation of several site plans to address specific issues individually and in detail. For example, a PPE training plan is recommended to ensure that workers know that the PPE is available and how to use it to maximize their safety.

Potential occupational health and safety risks would be limited during the site characterization phase because of the limited extent of activities. More occupational hazards would be present during construction, operation, and decommissioning of a solar energy facility; they can be minimized when workers adhere to safety standards and use appropriate protective equipment. However, fatalities and injuries from on-the-job accidents can occur, especially in association with heavy construction activities. Decommissioning activities are anticipated to be similar to construction activities; therefore, these activities are not duplicated in Table 5.8-1.

PV solar energy facilities do not generally involve hazardous liquids and gases, such as the heat fluids used in some concentrated solar power technologies; however, PV panels do contain potentially hazardous metals in solid form. These metals are encapsulated but potentially could be released to the environment on a small scale if one or several panels were broken or on a larger scale if the solar field caught fire.

In the near term, solar panels in the United States would likely use nonhazardous silicon-based semiconductor materials. However, semiconductors containing Cd, copper, gallium, indium, and/or arsenic compounds could be used in the future. Of these, Cd has the highest potential for use in utility-scale systems and is also highly toxic. Cadmium-based semiconductor modules contain about 7 g of Cd per square meter (Fthenakis and Zweibel 2003). Consequently, substantial quantities of Cd or other semiconductor metals may be present at utility-scale PV facilities.

Table 5.8-1. Occupational Health and Safety Hazards of PV Solar Energy Facilities and Associated Transmission Lines

Activity	Generic Hazard	Potential Control Measure
Construction[a]		
Clearing ROW and constructing access roads	Physical hazards from the use of heavy equipment and power saws; falling trees and branches; exposure to herbicides; bee stings and animal and insect bites; noise exposure; trips and falls; eye pokes; heat and cold stress; smoke inhalation	Daily safety briefing; PPE training plan; safeguards on equipment; safe practices for downing trees; safe operation of equipment; approved herbicide application procedures; onsite first aid capability
Constructing site facilities and substations, installing building foundations, placing equipment	General construction hazards; working around live electricity and energized equipment; exposure to hazardous materials	Electrical safety plan; hazardous materials safety plan
Installing electrical interconnect line support towers	Heavy equipment operation, crane operation; overhead work/falling items; falls from heights	Licensed equipment operators; work area controls; PPE/hard hats; safety equipment
Stringing conductors	Rotating equipment; lines under tension; suspended loads; overhead work/falling items	Work area controls; PPE; safety equipment
Installing underground electricity collector lines	Heavy equipment operation; buried utilities; falls in trenches	Trenching/confined-space entry plan; ground surveys
General construction activity: power tools	Employee injury from hand and portable power tools	Hand and portable power tool safety plan; PPE training plan
General construction activity: walking/working on surfaces	Employee injury/property damage from inadequate walking and work surfaces	Housekeeping and material-handling and storage plan
General construction activity: noise	Employee exposure to occupational noise	Hearing conservation plan; PPE training plan
General construction activity: injuries	Employee injury to head, eyes/face, hand, body, back, foot, and skin from work around cranes/hoists or other heavy equipment; exposure to hazardous substances; exposure to extreme heat	PPE training plan; injury prevention plan (including heat stress/stroke); hazard communication plan (including provision of material safety data sheets)
General construction activity: fall potential	Fall potential resulting from working in rugged areas	Injury prevention plan; safety harnesses and equipment; rescue response plan
General construction activity: welding	Employee exposure to compressed welding gases and to hazards of compressed air-driven tools and equipment	Hazard communication plan; gas-filled equipment safety plan; compressed gas storage, handling, and use training

Activity	Generic Hazard	Potential Control Measure
Installation and testing of electrical components	Shock/electrocution hazard	Special construction techniques and training; special personal protective devices, monitors
Installation and testing of gas-filled equipment	Employee injury and property damage due to failure of pressurized system components or unexpected release of pressure	Gas-filled equipment safety plan
General construction activity: working near/in water	Employee exposure to water (water crossings), drowning hazard	Special construction techniques and training; special personal protective devices, monitors
Dangerous animals/ insects/plants	Bites and injuries sustained from contact with dangerous animals, insects, and plants	Injury prevention plan; protective clothing; animal, pest, and vegetation control plan; onsite first-aid capability
Operations		
Daily operations; repairs to facility/ROW	Heavy equipment operation; working around energized electricity lines and shock hazards; exposure to herbicides; exposure to glare from PV arrays	Daily safety briefing; PPE training plan; electrical safety plan; injury prevention plan; licensed operators; safeguards on equipment; safe operation of equipment; approved herbicide application procedures; onsite first-aid capability
Electricity interconnect line maintenance	Falls from heights; shock hazards; risks of helicopter/airplane operation	Training; safety equipment; work in good weather
AC flow at solar field, substations, or along transmission lines	Magnetic field exposures	Minimizing distance from equipment or electricity line to receptors; line routing and ROW spacing
Induced currents along transmission lines	Corrosion of adjacent pipelines and other metallic buried infrastructure	Monitoring; cathodic protection systems; pipe coatings
Induced voltages	Shock hazards	AC mitigation installation; use of ground fault mats; grounding of metallic equipment and objects
Inspections conducted on the ground	Weather extremes; rugged terrain; dangerous animals, insects, and plants	Injury prevention plan; protective clothing; a Nuisance Animal and Pest Control Plan and Vegetation Management Plan; onsite first-aid capability

[a] Health and safety hazards during site decommissioning are similar to those occurring during construction.

The release of Cd and other heavy metals from broken modules and/or during fires constitutes an area of concern (Fthenakis and Zweibel 2003). Releases under normal operations could be through leaching from broken or cracked modules. In general, researchers have concluded that such releases would result in a negligible potential for human exposures (EPRI and PIER 2003; Fthenakis and Zweibel 2003).

5.8.1.2 Public Health and Safety

Health and safety risks to the general public can include physical hazards from unauthorized access to construction or operational areas of solar energy facilities and increased risk of traffic accidents in the vicinity of solar energy facilities. Because of the remote nature of most solar energy facilities, these health and safety risks are generally low but should be addressed in facility health and safety plans.

Risks from public exposure to hazardous substances through air emissions from solar energy facilities are low, because the few substances that are stored and used at the facilities in large quantities have low volatility and inhalation toxicity (see Sections 5.8.2.1 and 5.8.2.2). Small quantities of combustion-related hazardous substances may be emitted from diesel-burning construction equipment. In addition, during operations there may be emissions of similar combustion-related substances if diesel-burning backup generators are occasionally used. Because these would be small and temporary sources, however, emissions and corresponding health risks are likely to be small. Nevertheless, the health risks of such emissions should be evaluated at the project-specific level.

Electrically energized equipment and conductors associated with solar energy facilities and the transmission lines that serve them represent electrical hazards. Proper signage and or engineered barriers (e.g., fencing) would be necessary to prevent access to these electrical hazards by unauthorized individuals or wildlife.

Public exposures to magnetic fields associated with solar energy facilities would be expected to be negligible, because setback zones would require homes and occupied buildings to be located at distances from solar energy facilities and transmission lines that are beyond levels of exposure concern.

5.8.1.3 Potential Impacts of Accidents, Sabotage, and Terrorism

Owners and operators of critical infrastructure (which includes PV solar energy facilities) are responsible for ensuring the operability and reliability of their systems. To do so, they must evaluate the impacts on their system from all credible events, including natural disasters (landslides, earthquakes, storms, and so on) as well as mechanical failure, human error, sabotage, cyberattack, or deliberate destructive acts of both domestic and international origin, recognizing intrinsic system vulnerabilities, the realistic potential for each event/threat, and the consequences. This section discusses both the regulatory requirements for these assessments and the types of events that could occur at solar energy facilities and associated transmission lines.

5.8.1.3.1 Natural Events

There is a potential for natural events to affect human health and the environment during all phases of development of PV solar energy facilities. Such events include tornadoes, earthquakes, severe storms, and fires. Depending on the severity of the event, fixed components of a solar energy facility could be damaged or destroyed, resulting in economic, safety, and environmental consequences. The probability of a natural event occurring is location-specific and differs among the locations considered in this Programmatic EIS. Such differences should be taken into account during project-specific studies and reviews.

The consequences of natural events could include injuries, loss of life, and the release of hazardous materials to the environment. The likelihood of injuries and loss of life may be decreased by emergency planning (e.g., tornado drills) and onsite first-aid capabilities. For hazardous material releases, the potential types and quantities of materials that would be present at a solar energy facility and that potentially could be released to the environment during a natural event are discussed in Section 5.8.1. Researchers conducted experiments on the release of Cd from modules when burned at high temperatures and found that less than 0.04% of the Cd in modules would be released in fires (Fthenakis et al. 2004).

5.8.1.3.2 Sabotage or Terrorism

In addition to the natural events described above, there is a potential for intentional destructive acts to affect human health and the environment. In contrast to natural events, for which it is possible to estimate event probabilities based on historical statistical data and information, it is not possible to accurately estimate the probability of sabotage or terrorism. Consequently, discussion of the risks from sabotage or terrorist events generally focuses on the consequences of such events.

The consequences of a sabotage or terrorist attack on a solar energy facility would be expected to be similar to those discussed above for natural events. Depending on the severity of the event, fixed components of a solar energy facility could be damaged or destroyed, resulting in economic, safety, and environmental consequences. The potential consequences of such events need to be evaluated on a project- and site-specific basis.

5.8.2 Cumulative Impacts

Public health and safety risks from PV solar energy facilities include physical hazards from unauthorized access to construction or operational areas, especially if there is inadvertent access to electrically-energized equipment, potential exposures to hazardous substances or magnetic fields, and increased risk of fires. Air pollutant emissions from PV solar energy facilities are low. Occupational hazards would be controlled through adherence to injury prevention and electrical safety plans and appropriate use of PPE. Public and occupational safety risks would be low with adherence to programmatic design features. Solar energy development would involve activities that could spark a fire or change fire susceptibility, resulting in a contribution to the cumulative regional fire risk. However, these risks would be minimized through the development of a required project-specific Fire Prevention and Safety Plan. Other activities in the planning area would require similar adherence to safety plans and requirements in order to protect public health. With the implementation of these impact minimization measures, the contribution to cumulative impacts of the proposed program is not expected to be substantial.

5.8.3 Design Features

The BLM has identified design features that will be requirements for all utility-scale solar energy projects on BLM-administered lands subject to the ROD for this Programmatic EIS. The list of design features that have been identified to avoid, minimize, and/or compensate for potential impacts on health and safety from solar energy development can be found in Appendix B.8.

5.8.4 Comparison of Alternatives

5.8.4.1 No Action Alternative

Under the No Action Alternative, approximately 47.3 million acres of BLM-administered lands would be available for applications for solar energy development. Of the total lands available for application, 330,195 acres are located within existing priority areas, approximately 15.7 million acres are variance lands allocated in the 2012 Western Solar Plan for the six-state planning area, and approximately 31.6 million acres would be available for application within the five additional states considered in this Programmatic EIS, as these lands were not addressed in the 2012 Western Solar Plan. However, solar energy development is expected to occur only on approximately 700,000 acres (the RFDS value), or 1.4% of BLM-administered lands available for solar ROW application under the No Action Alternative. Public health and safety risks and occupational hazards described in Section 5.8.1 may occur from the construction and operation and decommissioning of PV solar energy facilities under the No Action Alternative. In the six states addressed under the 2012 Western Solar Plan, the design features from that plan would mitigate health and safety impacts. In the five new states, required mitigation measures for health and safety impacts would be established at the project-specific level.

5.8.4.2 Action Alternatives

Alternative 1. Approximately 55 million acres of BLM-administered lands would be available for utility-scale solar ROW application.

Alternative 2. Approximately 36.2 million acres of BLM-administered lands would be available for utility-scale solar application.

Alternative 3. Approximately 22.2 million acres of BLM-administered lands would be available for utility-scale solar application.

Alternative 4. Approximately 11.2 million acres of BLM-administered lands would be available for utility-scale solar application.

Alternative 5. Approximately 8.4 million acres of BLM-administered lands would be available for utility-scale solar application.

The RFDS estimates that solar energy development would occur only on approximately 700,000 acres within BLM-administered lands available under Alternatives 1 through 5.

Public health and safety risks and occupational hazards described in Section 5.8.1 may occur from the construction and operation and decommissioning of PV solar energy facilities under the Action Alternatives. The impacts on health and safety from the RFDS for utility-scale solar on BLM-administered lands within the planning area would be similar under all of the action alternatives, since risks to health and safety are generally independent of the geographic location of the development. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

5.9 Lands and Realty

5.9.1 Direct and Indirect Impacts

FLPMA of 1976, as amended, provides the authority to issue a ROW authorization to applicants to construct, operate, maintain, and terminate a solar energy project, including a substation; operations and maintenance facilities (including a BES system); transmission lines; and temporary construction laydown areas. Potential impacts on lands, realty, and cadastral survey from solar energy projects are discussed in terms of land ownership; compliance with management of lands and their boundaries; land use authorizations and ROWs (including lands, realty, and cadastral survey actions); and future or planned land uses.

5.9.1.1 Construction and Operations

BLM-administered lands within the 11-state planning area where utility-scale solar energy development might occur support a wide variety of activities, as described in Chapter 4. These uses are established by the BLM as part of the land use planning process, today known as resource management plans, or RMPs. One objective of the BLM's Lands and Realty Program is to issue ROWs on BLM-administered lands to any qualified individual, business, or government entity consistent with existing RMPs and pursuant to the applicable regulations. Most facilities are authorized for a specific time period, commonly 30 years, and for that time the authorized facility has a prior existing right to use the BLM-administered lands. The BLM has proposed a rule extending this period to 50 years for solar (and wind) energy developments (88 FR 39726). Development of solar energy facilities would be subject to valid existing rights and the BLM generally does not force changes in existing ROW authorizations. However, the BLM can change the terms and conditions of a grant as a result of changes in legislation, regulation, or as otherwise necessary to protect public health or safety or the environment.

The construction and operation of a solar energy project would have an impact on lands and realty if it conflicts with existing land use plans and community goals; conflicts with existing recreational, educational, religious, scientific, or other uses of the area; or conflicts with the existing commercial land use of the area (e.g., mineral extraction). In most areas of BLM-administered lands in the planning area, solar energy development would create an industrial landscape in stark contrast to the character of the existing undeveloped landscape. Once a solar energy facility is authorized, the area would be limited from use for other lands and realty purposes inconsistent with operation of the solar energy facility. The solar energy facility could serve as a barrier to other lands and realty uses, and would be more substantial for larger solar energy facilities (about 6,000 acres [24.3 km^2] for a 750-MW PV solar energy facility with storage or about 5,250 acres [21.2 km^2] for a similar PV facility without storage). A smaller-sized 5-MW solar energy facility would occupy 40 acres (0.16 km^2) for a site with storage or 35 acres (0.14 km^2) for one without storage; the impact on other lands and realty would not be as significant. A significant impact on lands and realty would occur from an uncompensated loss of the current productive use of the site or foreclosure of future land uses. However, permanently converted acreage would usually compose only a small portion of the area available for application within the 11-state planning area (e.g., state-, county-, or BLM Field Office–wide).

In addition to direct impacts, there may also be indirect impacts on lands and realty associated with solar energy development. The indirect impacts would be associated with changes to existing uses on public, state, and private lands that surround or are near solar energy facilities. Examples of these indirect impacts could include conversion of land in and around local communities from agricultural, open space, or other uses to provide services and housing for employees and families who move to the region in support of solar energy development. Increased traffic and increased access to previously remote areas also could change the overall character of the landscape, including the visual quality of large areas. These indirect impacts would vary project by project and need to be considered in a project-specific analysis.

Solar energy development could fragment a block of BLM-administered lands, creating isolated BLM-administered land parcels that are harder to manage. For example, a solar energy project may separate habitat features (e.g., food and water resources) for wildlife, livestock or WH&Bs; intersect a recreational use area such as hiking or OHV trails, or conflict with mineral extraction. Topography, land ownership patterns, existing land use designations (e.g., wilderness), and new access routes or transmission facilities are examples of features that all could combine with solar energy development to create fragmentation of BLM-administered lands. Private and state lands, present in close proximity to solar energy facilities, could also be affected. The potential also exists to sever access routes and adversely affect the uses of other public, state, and private lands including lands managed by other federal agencies. The potential magnitude and nature of these impacts should be considered in project-specific analyses.

At least locally, solar energy facilities would result in long-term impacts on lands and realty. Any land use activity such as grazing, recreation, mining, and other energy development activity would be affected if the land were converted for solar energy use. As mentioned, development of solar energy facilities would be subject to valid existing rights.

5.9.1.2 Transmission Lines and Roads

While this Solar Programmatic EIS considers the impacts of constructing, operating, and decommissioning the related infrastructure needed to support utility-scale solar energy development, such as transmission lines and access roads, the land use plan decisions will apply only to utility-scale solar energy generation facilities. Management decisions for supporting infrastructure would continue to be made in accordance with existing land use plan decisions and current applicable policies and procedures. The siting of supporting infrastructure, as well as the solar energy facility itself, would be fully analyzed in project-specific environmental reviews in accordance with NEPA. Such reviews would be completed in combination with solar energy generation facility environmental reviews as appropriate.

For lands not administered by the BLM, authorization for transmission lines and road would be obtained as purchases, easements, or leases, as appropriate. These non-BLM-administered lands would be considered in accordance with BLM processing procedures during project-specific analyses. The primary land use change associated with transmission lines and roads associated with a solar energy facility would be the development of currently natural or undeveloped land for new and/or upgraded transmission lines and ancillary facilities (i.e., substations, access roads).

Transmission facilities, although they do not completely limit other uses, limit the uses of the land on which they are located and would have a long-lasting impact on future land uses. The construction of new transmission facilities would have both direct and indirect impacts. Direct impacts (such as the loss of land to physical structures, impacts on wildlife from keeping ROWs free of major vegetation (e.g., trees), maintenance of service roads, and increased traffic along transmission maintenance roads) would exist as long as the transmission lines are in place. Indirect impacts could include the introduction of or an increase in recreational use due to improved access, avoidance of an area for recreational use for aesthetic reasons, introduction of invasive species along service roads, and adverse impacts on scenic viewsheds. Access roads could improve motorized and non-motorized access to previously inaccessible areas, affecting such activities as grazing and recreation. The magnitude and extent of the impact would depend on the current land use in the area and project-specific analyses.

5.9.1.3 Decommissioning/Reclamation

Decommissioning activities (including reclamation) are not anticipated to result in impacts on surrounding land uses, realty, and management of land boundaries. They would conform with project reclamation plans, which would be reviewed by the BLM and required to include then-current land use plans, policies, and regulations. Following facility decommissioning, lands would be reclaimed and returned to their pre-project state, to the extent feasible. Lands associated with the project site would remain under BLM management and would be available for use in accordance with the BLM's multiple-use mandate. The BLM could decide to continue the use of access roads. Decommissioning would make the transmission line available for other similar uses, or could be completely reclaimed and reverted to preexisting conditions (BLM 2020c).

5.9.2 Cumulative Impacts

Cumulative impacts on lands, realty, and cadastral survey could result from the physical division of an established land use, fragmentation resulting in an increase of specially designated areas and more boundaries to be appropriately managed, or from conflicts with any applicable land use plans, policies, or regulations adopted for the purpose of avoiding or otherwise mitigating environmental impacts. In a worst-case scenario, the development of multiple solar energy projects within the same area could create a substantial adverse cumulative impact to surrounding land and realty uses if the projects were built on or adjacent to areas with other prior planned uses.

Solar energy facilities could be built in rural areas within the 11-state planning area. Placing PV solar energy facilities in these areas usually represents a new and different land use, creating areas of commercial character in rural environments. Based on the RFDS, it is expected that utility-scale facilities would block out large tracts of BLM-administered land through 2045, cumulatively totaling approximately 700,000 acres on BLM-administered lands and 600,000 acres of other lands (including private lands and state-owned lands) across the 11-state planning area, removing or limiting many current land uses. The surface area required by solar energy facilities would render the project area incompatible for most other uses, including grazing, most mineral development, and recreation. Existing ROWs representing prior rights would be honored, however, and BLM-administered land use plans would be revised to accommodate solar energy development.

Contributions of solar energy development to cumulative impacts on lands and realty would be in addition to those from ROWs for transmission lines, roads, and other facilities on BLM-administered lands and from other energy development on public and private lands that would further affect and limit other land uses within a given region. Renewable energy development is expected to be the largest potential new future use of rural lands. Additional energy transmission and other linear systems are also expected, some of which would be built to serve renewable energy development. Lesser amounts of acquisitions, exchanges, donations, disposal, and sales would also occur partially offsetting increased specially designated area boundaries to be managed from solar energy development. Thus, renewable energy development would be a major new contributor to cumulative impacts on land use in the planning area. Solar energy development, because of its intensive land use, would be a major contributor to those impacts.

5.9.3 Design Features and Additional Mitigation Measures

The BLM has identified design features that will be requirements for all utility-scale solar energy projects on BLM-administered lands subject to the ROD for this Programmatic EIS. The list of design features that have been identified to avoid, minimize, and/or compensate for potential impacts on lands and realty from solar energy development can be found in Appendix B.9.

In addition to the design features, the following mitigation measure may be useful in avoiding, minimizing, and/or mitigating some impacts on Lands and Realty:

- Project developers should consider opportunities to consolidate and/or collocate use of existing supporting infrastructure, especially for cases where two solar energy facilities are in close proximity, in order to maximize the efficient use of BLM-administered lands and minimize impacts.

5.9.4 Comparison of Alternatives

5.9.4.1 No Action Alternative

Under the No Action Alternative, approximately 47.3 million acres of BLM-administered lands would be available for applications for solar energy development. Of the total lands available for application, 330,195 acres are located within existing priority areas, approximately 15.7 million acres are variance lands allocated in the 2012 Western Solar Plan for the six-state planning area, and approximately 31.6 million acres would be available for application within the five additional states considered in this Solar Programmatic EIS, as these lands were not addressed in the 2012 Western Solar Plan. Of the open available lands, under the RFDS the BLM estimates that approximately 700,000 acres (1.4%) of BLM-administered lands will host utility-scale PV solar energy development over the next 20 years. Lands and realty impacts described in Section 5.9.1 could occur from the construction and operation of PV solar energy facilities under the No Action Alternative. In the six states addressed under the 2012 Western Solar Plan, the design features from that plan would mitigate impacts on lands and realty. In the five new states, required mitigation measures for impacts on lands and realty would be established at the project-specific level.

5.9.4.2 Action Alternatives

Alternative 1. Approximately 55 million acres of BLM-administered lands would be available for utility-scale solar application; however, the RFDS assumes that solar energy development would be limited to approximately 700,000 acres, which is about 1% of the BLM-administered lands available for solar ROW application under Alternative 1. Alternative 1 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria, while making all other lands available for application. Alternative 1 would make more lands available for application than are currently available under the No Action Alternative. The magnitude of impacts on lands and realty would depend on the location of solar energy development, proximity to existing infrastructure, and potential need for new offsite ROWs. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 2. Approximately 36.2 million acres of BLM-administered lands would be available for utility-scale solar application; however, the RFDS assumes that solar energy development would be limited to approximately 700,000 acres, which is about 2% of the BLM-administered lands available for solar ROW application under Alternative 2. Alternative 2 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based and a >10% slope exclusion. The magnitude of impacts on lands and realty would depend on the location of solar energy development, proximity to existing infrastructure, and potential need for new offsite ROWs. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 3. Approximately 22.2 million acres of lands would be available for solar energy development on BLM-administered lands; however, the RFDS assumes that solar energy development would be limited to approximately 700,000 acres, which is about 3% of the BLM-administered lands available for solar ROW application under Alternative 3. Alternative 3 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a >10% slope exclusion. Alternative 3 would also limit development to areas that are less than 10 miles from existing or planned transmission lines of >100 kV, , focusing development in areas that may be more likely to be economically feasible for development. Limiting solar energy development to within 10 miles of existing or planned transmission lines may reduce impacts on lands and realty by limiting the number and distance of any new transmission lines and ROWs needed to transport the utility-scale solar energy development to existing transmission lines. The magnitude of impacts on lands and realty would depend on the location of solar energy development, proximity to existing infrastructure, and potential need for new offsite ROWs. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 4. Approximately 11.2 million acres of BLM-administered lands would be available for utility-scale solar application; however, the RFDS assumes that solar energy development would be limited to approximately 700,000 acres, which is about 6% of the BLM-administered lands available for solar ROW application under Alternative 4. Alternative 4 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a >10% slope exclusion, and limiting development to previously disturbed lands, limiting the area in which new land disturbance could occur. The magnitude of impacts on lands and realty would depend on the location of solar energy development, proximity to existing infrastructure, and potential need for new offsite ROWs. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 5. Approximately 8.4 million acres of BLM-administered lands would be available for utility-scale solar application; however, the RFDS assumes that solar energy development would be limited to approximately 700,000 acres, which is about

8% of the BLM-administered lands available for solar ROW application under Alternative 5. Alternative 5 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a >10% slope exclusion. Alternative 5 would also combine the requirement that development be limited to areas that are less than 10 miles from existing or planned transmission lines of >100 kV (from Alternative 3) with the requirement to limit development to previously disturbed lands (from Alternative 4), making it the alternative with the least lands available for solar ROW application. Alternative 5 provides a focus on areas that may be more likely to be economically feasible for development because the lands available are near the transmission grid and limit the amount of new land disturbance. Limiting solar energy development to within 10 miles of existing or planned transmission lines may reduce impacts on lands and realty by limiting the number and distance of any new transmission lines and ROWs needed to transport the utility-scale solar energy development to existing transmission lines. The magnitude of impacts on lands and realty would depend on the location of solar energy development, proximity to existing infrastructure, and potential need for new offsite ROWs. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

5.10 Military and Civilian Aviation

5.10.1 Direct and Indirect Impacts

Development of utility-scale solar energy facilities has the potential to affect both military and civilian aircraft operations, radar use, and other operations. Developers of solar energy facilities would have to consider the needs of, and likely restrictions posed by, nearby military and civilian aviation facilities, installations, airspace, and other activities. As addressed in Section 4.10, numerous civilian airfields, airstrips, military training routes (MTRs), and Special Use Airspace (SUA) areas occur within the 11-state planning area. The military airspace in the 11-state planning area is intensively used and is important to maintaining overall training and readiness for all branches of the military. The decision-making process in siting both utility-scale solar energy facilities and associated transmission lines must consider intrusion into low-level airspace and location relative to airports, airfields, and airstrips. For example, if a solar energy facility is located in close proximity to an airport or under an aircraft flight path, the glint and glare from reflective surfaces could adversely affect pilot control of aircraft and would have to be considered a potential aircraft hazard. Conversely, the impacts of military overflights, especially supersonic flights, on solar energy facilities should be considered (e.g., the potential for solar field equipment damage) as part of project design and location.

5.10.1.1 Construction and Operations

Construction of a solar energy facility could potentially impact aviation activities if a structure or equipment were positioned such that it would be a hazard to navigable airspace. The FAA has established reporting requirements for construction or alterations around airport and heliport facilities that meet certain criteria regarding final height above ground level and penetration of an imaginary conical surface extending out from the air facility (BLM 2018c).

The location of a large-scale solar energy development in areas used by aviation either near airports, airfields, or airstrips, or along common flight paths could introduce safety concerns such as possible glare (reflectivity), radar interference, and physical penetration of airspace (FAA 2018). In addition, impacts on airborne and ground-based radars including weather radar must be considered. Also, potential impacts on aircraft performance and on pilots, such as the creation of thermal plumes, glare, and light pollution in both the visible and infrared spectra, are poorly understood and require further study.

The FAA will be involved in reviewing potential air space conflicts including any solar energy facility construction proposed near civilian airports, airfields, or airstrips. The Obstruction to Navigation Federal Regulation (49 CFR Part 77) requires FAA approval of any project more than 200 ft (61 m) tall. PV facilities are well under this height. An FAA finding of No Hazard to Air Navigation does not address all military airspace and other issues; coordination with the military command responsible for management of the training space would still be required.

Airports require clear zones for aviation safety. Clear zones vary according to airport activity and the types of operating aircraft. Large airports and military facilities have more extensive requirements than smaller airports and landing strips. Clear zone requirements typically involve a three-dimensional space free of aviation obstacles. In some areas, guy wires, towers, transmission lines, tall buildings, and other possible aviation hazards are marked, lighted, and/or charted based on FAA requirements. FAA requirements also cover an airport’s radar, flight control instruments, flight paths, and other fundamental aspects of airport operations and safety. Standards are applied along with customization to address actual conditions at individual airports (BLM 2015b).

While some localized glare could occur should low-flying aircraft travel close to a solar array, glare is not expected to significantly affect airspace safety or operations. There could be a potential for glare-related impacts if air traffic approaching a runway situated close to a solar energy facility has solar panels facing them. However, interference with pilot vision is not expected to have a significant impact, especially with use of glare-reducing design features (Appendix B, Section B.10).

Potential radar interference would generally occur only if a solar energy facility was located within a few hundred feet of a radar installation, while physical penetration of airspace is mainly a concern for objects taller than 200 ft (61 m). Therefore, solar PV projects are generally compatible with land use, even at airports, because of their low profile (FAA 2018).

5.10.1.2 Transmission Lines and Roads

With respect to air traffic, electric transmission lines, even heights below 200 ft (61 m), could pose a potential hazard to low-flying aircraft. Installation of a new transmission line to connect the site to the electric grid would need to take civil and military considerations into account including runway approach patterns and low-altitude military flight paths. Routes for transmission lines associated with proposed solar energy facilities may be in close proximity to existing or planned transmission lines [e.g., within 10 mi (16 km) depending on alternative]. The military would already be aware of transmission line concerns within those areas. The key determinants for an effect are proximity between flight paths and transmission line locations and heights and compliance with applicable requirements. A project would be designed to comply with FAA regulations, including lighting regulations, to avoid potential safety issues associated with proximity to airports, military bases or training areas, or landing strips. In addition, coordination with military areas is required to avoid conflicts. Lighting requirements and related details will be formally defined after selection and pre-construction engineering of the final alignment. Structure heights will be less than 200 ft, where feasible, to minimize the need for aircraft obstruction lighting (BLM 2015b).

Facilities placed in remote locations would be far from most receptors and therefore potential impacts are limited to passing aircraft. Because the intensity of the light reflected from the solar panels decreases with increasing distance, an appropriate question is how far an individual needs to be from a solar-reflected surface to avoid flash blindness. It is known that this distance is directly proportional to the size of the array in question (FAA 2018), and would need to be considered in greater detail in project-specific analyses.

The possibility of electrical interference of transmission lines (or solar array control systems) with aircraft operations is remote but should be evaluated for any new installation. Interactions with low-altitude aircraft electronic components or communications have the potential to occur if corona discharges from the transmission lines are not minimized and if specific electric frequencies are not avoided.

5.10.1.3 Decommissioning

Activities occurring during decommissioning would be similar to those from construction, and would not be expected to affect aviation. Removal of the PV panels would eliminate a potential source of glare; while removal of transmission lines could reduce hazards to low-flying aircraft.

5.10.2 Cumulative Impacts

The air space above many of the areas suited to solar energy development is currently used for MTRs and SUA. MTRs and SUA located over prospective solar energy development areas have varying airspace authorizations (i.e., specific heights designated for military use), and coordination and/or consultation with the DOD may identify restrictions on the height of any facilities that might be constructed within these routes. Such restrictions likely would not constrain the use of solar PV technologies that might be deployed. The construction of high-voltage transmission lines is more likely to conflict with military airspace use, which could constrain the size and routes of such lines. The addition of transmission lines associated with future solar energy development would add to existing transmission lines that currently exist or are approved within the 11-state planning area. Glint and glare from solar energy facilities and any other facilities with reflective surfaces are an additional concern to military and civilian pilots. Under the RFDS, the BLM estimates that a total combined area of approximately 700,000 acres of BLM-administered lands and 600,000 acres of other lands (including private lands and state-owned lands) across the 11-state planning area will host utility-scale PV solar energy development over the next 20 years. The RFDS land-use projections would affect a relatively small proportion of total BLM-administered lands in the planning area. However, small cumulative impacts on military aviation could occur from general development in the 11-state planning area, including that from solar energy facilities, even with established training routes and height restrictions, because of general infringement on formerly wide-open spaces. The military has expressed concerns regarding the possible impacts of solar energy facilities on its training mission. The design features presented in Appendix B, Section B.10 would require coordination with the military regarding the location of solar energy projects early in the application process and land use planning stage.

Civilian aviation would likely be much less affected than military aviation by PV solar energy development. Airports are generally located near towns or cities and at some distance from prospective solar energy development areas. Moreover, civilian aviation would not involve low-altitude flights and the attendant need for height restrictions on infrastructure, other than in the immediate area of runways. The location of runways is factored into decisions on location of solar energy facilities in or near airports. Other than potential glint or glare concerns, no other cumulative impacts on civilian or military aviation are expected.

5.10.3 Design Features

The BLM has identified design features that will be requirements for all utility-scale solar energy projects on BLM-administered lands subject to the ROD for this Programmatic EIS. The list of design features that have been identified to avoid, minimize, and/or compensate for potential impacts on military and civilian aviation from solar energy development can be found in Appendix B.10.

5.10.4 Comparison of Alternatives

5.10.4.1 No Action Alternative

Under the No Action Alternative, approximately 47.3 million acres of BLM-administered lands would be available for applications for solar energy development. Of the total lands available for application, 330,195 acres are located within existing priority areas, approximately 15.7 million acres are variance lands allocated in the 2012 Western Solar

Plan for the six-state planning area, and approximately 31.6 million acres would be available for application within the five additional states considered in this Programmatic EIS, as these lands were not addressed in the 2012 Western Solar Plan. However, solar energy development is expected to occur only on approximately 700,000 acres (the RFDS value), or 1.4% of BLM-administered lands available for solar ROW application under the No Action Alternative. Military and civilian aviation impacts described in Section 5.10.1 could occur from the construction and operation and decommissioning of PV solar energy facilities and, particularly, associated transmission lines under the No Action Alternative. In the six states addressed under the 2012 Western Solar Plan, the design features from that plan would mitigate impacts on military and civilian aviation. In the five new states, required mitigation measures for military and civilian aviation impacts would be established at the project-specific level.

5.10.4.2 Action Alternatives

Alternative 1. Approximately 55 million acres of BLM-administered lands would be available for utility-scale solar application.

Alternative 2. Approximately 36.2 million acres of BLM-administered lands would be available for utility-scale solar application.

Alternative 3. Approximately 22.2 million acres of BLM-administered lands would be available for utility-scale solar application.

Alternative 4. Approximately 11.2 million acres of BLM-administered lands would be available for utility-scale solar application.

Alternative 5. Approximately 8.4 million acres of BLM-administered lands would be available for utility-scale solar application.

The RFDS estimates that solar energy development would occur only on approximately 700,000 acres within BLM-administered lands available under Alternatives 1 through 5. Military and civilian aviation impacts described in Section 5.10.1 could occur from the construction and operation and decommissioning of PV solar energy facilities and, particularly, associated transmission lines under the Action Alternatives. The impacts on military and civilian aviation from development to the RFDS level on BLM-administered lands within the planning area would be similar under all of the Action Alternatives. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

5.11 Mineral Resources

5.11.1 Direct and Indirect Impacts

A substantial portion of BLM-administered land within the 11-state planning area is valuable to supporting current and future fluid and solid mineral resource development and extraction. Utility-scale solar energy development could affect the ability to develop and extract these resources where mineral development would be incompatible with the previously authorized solar energy development. Federal Regulations 43 CFR Parts 2090 and 2800 provide for temporary segregation of renewable energy ROW (wind or solar) to promote the orderly administration of the ROW process (78 FR 25204).

5.11.1.1 Construction and Operation

Impacts on mineral resources could result where the authorization to site a solar project reduces the current or future availability of mineral resource areas identified within the planning area. However, the authorization to site a solar project may not fully preclude mineral extraction. For example, fluid minerals and geothermal resources could be potentially accessed by directional drilling. Additionally, a small portion of the solar field could be used as a well pad or a gravel mine where it is deemed compatible with the solar authorization. Further, federal regulations allow use of common varieties of stone and soil by the ROW Holder which are removed during construction of the project, without additional authorization or payment, in constructing the project within the authorized ROW. If some mineral access is interrupted by a solar energy project, the resulting impact would be moderate to high if there are not similar options to obtain those minerals within a reasonable distance. A low to negligible impact would occur in an area with no known active mines or mining claims, oil or gas wells, geothermal resources, coal or other mineral leases, or mineral resources.

To capture a range of possible impacts of the construction and operation of individual solar energy facilities, a 5 to 750 MW range of facility capacity is presented (see Section 3.1.2). The land disturbance for a single 750-MW PV solar energy facility with storage would be about 6,000 acres (24.3 km^2) or about 5,250 acres (21.2 km^2) for a similar PV facility without storage. The land disturbance for a 5-MW PV solar energy facility with storage would be about 40 acres (0.16 km^2) or about 35 acres (0.14 km^2) for one without storage. The impacts on minerals would vary by mineral resource and flexibility to access those minerals but would occur for the life of the project. Because utility-scale solar energy development would be disrupted by most mineral development activities, the BLM generally precludes mineral development within solar energy development ROW areas once authorized, unless determined compatible by the BLM. Additionally, the BLM may also “preclude” non-discretionary locatable mineral “entry” through the process of a land withdrawal. Areas can be temporarily segregated as noted above. Withdrawal actions typically last for 20 years and can be extended. Segregation actions typically last 2 years and can be extended one time for an additional 2 years. Exceptions also could allow for discretionary actions, such as accessing oil and gas or geothermal resources under a solar energy facility using offset drilling technologies (BLM 2018a), underground mining methods for solid minerals, or in situ leaching. However, access roads developed for the project could provide improved access for mineral extraction in the project area.

A solar energy facility would have no direct or indirect impacts on the production of locatable or leasable minerals outside of the proposed site boundaries. If a mine begins operation in the general vicinity of an existing solar energy facility, the existence of the facility is not expected to interfere with the ability of the claimant to access those minerals. Any conflicts between the surface use of the land for solar energy production and access to minerals would be addressed in accordance with appropriate regulations.

Operation and maintenance activities on the solar energy facility would not directly affect the operation of existing mines outside of the project site. However, indirect impacts could occur if project-related closure or blockage of public roads or access routes reduces access to any off-site mineral resource areas. The presence of the project would not prevent prospectors or mineral lessees in the surrounding region from accessing areas outside the solar energy facility, because there are likely other routes available to access surrounding areas (BLM 2012k).

5.11.1.2 Transmission Lines and Roads

While this Solar Programmatic EIS considers the impacts of constructing, operating, and decommissioning the related infrastructure needed to support utility-scale solar energy development, such as transmission lines and access roads, the land use plan decisions to be made will be applicable only to utility-scale solar energy generation site facilities. Management decisions for supporting infrastructure would continue to be made in accordance with existing land use plan decisions and current applicable policy and procedures. The siting of supporting infrastructure would be fully analyzed in project-specific environmental reviews in accordance with NEPA. Such reviews would be completed in combination with solar generation facility environmental reviews as appropriate.

Existing mining claims, oil and gas leases, or other types of mineral leases, contracts, or permits would preclude or could affect the location of ROWs for transmission lines serving solar energy facilities, although in most instances it is likely that ROWs could be located to avoid areas of mineral development or in a manner consistent with planned mineral development. Authorized ROWs would result in constraints on new mineral development activities, assuming the ROW was issued prior to a mining claim being duly filed.

Transmission lines typically have little impact on mining operations. Span lengths are such that access to minerals can be accomplished between spans. Should open pit mining be planned, structures can be left on “islands,” or the mining interests can have the transmission line locally re-routed (BLM and Western 2015). Also, the BLM cannot take actions that will interfere with development of a mining operation or deny access to the located mineral.

Operation and maintenance activities would include the upkeep of access roads, which could include the occasional application of new gravel surfaces to ensure the integrity of these road surfaces. Gravel resources from the predetermined on- or offsite sources may be extracted according to federal and state regulations for road maintenance throughout the lifespan of the project. The quantity of aggregate required for operation and maintenance should be less than that needed for initial construction.

5.11.1.3 Decommissioning

If a facility did interfere with access to mineral resources during the life of the project, these resources would be preserved and would be available following project decommissioning (BLM 2013d). Decommissioning of a solar energy facility would remove project components, thereby making the land available for future exploration or production of aggregate materials. Therefore, decommissioning would not cause any adverse impacts on the availability of regionally or locally important mineral resources (BLM 2015c).

5.11.2 Cumulative Impacts

Numerous existing mining interests that represent prior existing rights lie within areas available for solar ROW application; these areas would either have to be avoided during PV solar project siting, or new rights negotiated.

In FY 2022, the BLM managed 26,220 oil and gas leases on about 19 million acres across the 11-state planning area (BLM 2023p). In FY 2022, there were 19,366 producible oil and gas leases on BLM-administered lands across 11 million acres, which accounts for 11% of all oil and 9% of all the natural gas produced domestically (BLM 2022j, 2023p). The highest producing states in the 11-state planning area were Wyoming, New Mexico, Colorado, and Utah. The Energy Information Administration (EIA) projects that petroleum and natural gas production will remain high in response to international demand (EIA 2023d).

In 2021, over half of the total U.S. coal production (577.4 million short tons) was produced in the western states (EIA 2022d). However, coal production has been decreasing and the EIA projects a sharp decline in U.S. production of coal by 2030 to about 50% of current levels, with a more gradual decline between 2030 and 2050 (EIA 2012, 2022d, 2023d).

Across 11 western states and Alaska, approximately 27% (143 million acres) of the total area containing geothermal resources with potential for electricity generation or heating applications is on BLM-administered lands (BLM and USFS 2008). Currently 48 geothermal power plants operate on BLM-administered lands with a combined total of more than 2.5 GW of generation capacity (BLM undated k). Nationwide, geothermal capacity is expected to increase by an additional 2.5 GW by 2050 (EIA 2023d). By the end of FY 2022, there were 536 competitive, noncompetitive, and private geothermal leases, covering over 1.1 million acres within California, Colorado, Idaho, Nevada, New Mexico, Utah, and Washington (BLM 2023p).

By the end of FY 2022, there were 482,141 active mining claims, covering 11 million acres on BLM-administered lands within the 11-state planning area, with the highest number (247,187) in Nevada (BLM 2023p), a 21% increase from FY 2012 (BLM 2013e). The number of leases and associated acres for sodium mining has increased since FY 2012, and phosphate, and gilsonite leases have remained steady (BLM 2013e, 2023p).

Under the RFDS, the BLM estimates that a total combined area of approximately 700,000 acres of BLM-administered lands and 600,000 acres of other lands (including private lands and state-owned lands) across the 11-state planning area will host utility-scale PV solar energy development over the next 20 years. Solar energy facilities would be incompatible with most types of mineral production because of the intensive land coverage required. Underground mining might remain viable beneath solar energy facilities, as would oil and gas recovery using directional drilling. Geothermal resources might also be recoverable in solar energy development areas. Other land uses such as wind energy development, critical habitats, SDAs, livestock grazing, and WH&B HMAs could contribute additional impacts on mineral resources by further reducing the land available for minerals development. Following solar energy project decommissioning, the lands could be available for mineral development and extraction to occur. Given projected increases in geothermal, oil, and gas development; the historical increases in mining claims and leases; and other resource uses, there is potential for impacts on mineral resources if construction and operation of a solar energy project reduces future availability of mineral resource areas identified within the planning area. The level of impact would depend on the project-specific locations of future solar energy development and their proximity to mineral resources.

5.11.3 Design Features

The BLM has identified design features that will be requirements for all utility-scale solar energy projects on BLM-administered lands subject to the ROD for this Programmatic EIS. The list of design features that have been identified to avoid, minimize, and/or compensate for potential impacts on mineral resources from solar energy development can be found in Appendix B.11.

5.11.4 Comparison of Alternatives

5.11.4.1 No Action Alternative

Under the No Action Alternative, approximately 47.3 million acres of BLM-administered lands would be available for applications for solar energy development. Of the total lands available for application, 330,195 acres are located within existing priority areas, approximately 15.7 million acres are variance lands allocated in the 2012 Western Solar Plan for the six-state planning area, and approximately 31.6 million acres would be available for application within the five additional states considered in this Programmatic EIS, as these lands were not addressed in the 2012 Western Solar Plan. Lands within SEZs remain withdrawn from locatable mineral entry under the mining laws until 2032. Of the open available lands, under the RFDS the BLM estimates that approximately 700,000 acres of BLM-administered lands will host utility-scale PV solar energy development over the next 20 years, which could impact mining development and extraction activities depending on where solar energy developments are authorized within the planning area. In the six states addressed under the 2012 Western Solar Plan, the design features from that plan would mitigate mineral resource impacts. In the five new states, required mitigation measures for mineral resource impacts would be established at the project-specific level.

5.11.4.2 Action Alternatives

Alternative 1. Approximately 55 million acres of BLM-administered lands would be available for utility-scale solar ROW application; however, of those lands, 31,549 acres within SEZs are withdrawn from locatable mineral entry under the mining laws until 2032. Mineral development within the project ROW for utility-scale solar energy development is generally an incompatible use; however, some resources underlying the project areas might be developable (e.g., directional drilling for oil and gas or geothermal resources, underground mining). Some mining operations could be affected by solar energy development ROW authorizations through a reduction in future availability of mineral resource areas identified within the planning area; however, the RFDS estimates that solar energy development would occur only on approximately 700,000 acres, which is about 1% of the BLM-administered lands available for solar ROW application under Alternative 1. Alternative 1 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria, while making all other lands available for application. Alternative 1 would make more lands available for application than are currently available under the No Action Alternative. The magnitude of impacts on minerals would depend on the location of solar energy development in proximity to mineral resources and potential future mineral operations. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 2. Approximately 36.2 million acres of BLM-administered lands would be available for utility-scale solar ROW application; however, of those lands, 31,549 acres within SEZs are withdrawn from locatable mineral entry under the mining laws until 2032. Mineral development within the project ROW for utility-scale solar energy development is generally an incompatible use; however, some resources underlying the project areas might be developable (e.g., directional drilling for oil and gas or geothermal resources, underground mining). Some mining operations could be affected by solar energy development ROW authorizations through a reduction in future availability of mineral resource areas identified within the planning area; however, the RFDS estimates that solar energy development would occur only on approximately 700,000 acres, which is about 2% of the BLM-administered lands available for solar ROW application under Alternative 2. Alternative 2 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a >10% slope exclusion. The magnitude of impacts on minerals would depend on the location of solar energy development in proximity to mineral resources and potential future mineral operations. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 3. Approximately 22.2 million acres of public lands would be available for utility-scale solar ROW application; however, of those lands, 31,549 acres within SEZs are withdrawn from locatable mineral entry under the mining laws until 2032. Mineral development within the project ROW for utility-scale solar energy development is generally an incompatible use; however, some resources underlying the project areas might be developable (e.g., directional drilling for oil and gas or geothermal resources, underground mining). Some mining operations could be affected by solar energy development ROW authorizations through a reduction in future availability of mineral resource areas identified within the planning area; however, the RFDS estimates that solar energy development would occur only on approximately 700,000 acres, which is about 3% of the BLM-administered lands available for solar ROW application under Alternative 3. Alternative 3 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a >10% slope exclusion. Alternative 3 would also limit development to areas that are less than 10 miles from existing or planned transmission lines of >100 kV, focusing development in areas that may be more likely to be economically feasible for development. The magnitude of impacts on minerals would depend on the location of solar energy development in proximity to mineral resources and potential future mineral operations. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 4. Approximately 11.2 million acres of BLM-administered lands would be available for utility-scale solar ROW application; however, of those lands, 31,549 acres within SEZs are withdrawn from locatable mineral entry under the mining laws until 2032. Mineral development within the project ROW for utility-scale solar energy development is generally an incompatible use; however, some resources underlying the project areas might be developable (e.g., directional drilling for oil and gas or geothermal resources, underground mining). Some mining operations could be affected by solar energy development ROW authorizations through a reduction in future availability of mineral resource areas identified within the planning area; however, the RFDS estimates that solar energy development would occur only on approximately 700,000 acres, which is about 6% of the BLM-administered lands available for solar ROW application under Alternative 4. Alternative 4 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria, a >10% slope exclusion, and limiting development to previously disturbed lands, limiting the area in which new land disturbance could occur. The magnitude of impacts on minerals would depend on the location of solar energy development in proximity to mineral resources and potential future mineral operations. The exclusion of more intact lands could drive solar energy development to areas where current and past development (possibly including mineral operations) is more prevalent. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 5. Approximately 8.4 million acres of BLM-administered lands would be available for utility-scale solar ROW application. However, of those lands, 31,549 acres within SEZs are withdrawn from locatable mineral entry under the mining laws until 2032. Mineral development within the project ROW for utility-scale solar energy development is generally an incompatible use; however, some resources underlying the project areas might be developable (e.g., directional drilling for oil and gas or geothermal resources, underground mining). Some mining operations could be affected by solar energy development ROW authorizations through a reduction in future availability of mineral resource areas identified within the planning area; however, the RFDS estimates that solar energy development would occur only on approximately 700,000 acres, which is about 8% of the BLM-administered lands available for solar ROW application under Alternative 5. Alternative 5 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a >10% slope exclusion. Alternative 5 would also combine the requirement that development be limited to areas that are less than 10 miles from existing or planned transmission lines of >100 kV (from Alternative 3) with the requirement to limit development to previously disturbed lands (from Alternative 4), making it the alternative with the least lands available for solar ROW application. Alternative 5 provides a focus on areas that may be more likely to be economically feasible for development because the lands are near the transmission grid and limit the amount of new land disturbance. The exclusion of more intact lands could drive solar energy development to areas where current and past development (including mineral operations) is more prevalent. The magnitude of impacts on minerals would depend on the location of solar energy development in proximity to mineral resources and potential future mineral operations. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

5.12 Paleontological Resources

Future development of solar energy facilities could impact paleontological resources in and around the areas where those facilities are built. Impacts would occur primarily during facility construction due to surface disturbance, but indirect impacts from facility operations could also occur. The following subsections discuss the common impacts on such resources from solar energy development.

5.12.1 Direct and Indirect Impacts

Significant paleontological resources could be affected by utility-scale solar energy development. The potential for impacts on paleontological resources from solar energy development, including ancillary facilities, such as access roads and transmission lines, is directly related to the location of the project regardless of the amount of land disturbance in areas where paleontological resources could be present. Indirect impacts, such as impacts resulting from the erosion of disturbed land surfaces and from increased accessibility to possible site locations, are also considered.

Impacts on paleontological resources could result in several ways, as described below.

- Complete destruction of the resource and loss of valuable scientific information could result from the clearing, grading, and excavation of the project area and from construction of facilities and associated infrastructure if paleontological resources are exposed within the development area.

- Degradation and/or destruction of near-surface paleontological resources and their stratigraphic context could result from the alteration of topography; alteration of hydrologic patterns; removal of soils; erosion of soils; runoff into and sedimentation of adjacent areas; and oil or other contaminant spills if near-surface paleontological resources are located on or near the project area. Such degradation could occur both within the project ROW and in areas downslope or downstream. While the erosion of soils could negatively affect near-surface paleontological localities downstream of the project area by potentially eroding materials and portions of sites, the accumulation of sediment could serve to remove from scientific access, but otherwise protect, some localities by increasing the amount of protective cover. Agents of erosion and sedimentation include wind, water, downslope movements, and both human and wildlife activities.
- Increases in human access and subsequent disturbance (e.g., looting and vandalism) of near-surface paleontological resources could result from the establishment of corridors or facilities in otherwise intact and inaccessible areas. Increased human access (including OHV use) exposes paleontological sites to a greater probability of impact from a variety of stressors.

Paleontological resources are nonrenewable and, once damaged or destroyed, cannot be recovered. Therefore, if a paleontological resource (specimen or assemblage) or site is damaged or destroyed during utility-scale solar energy development, this scientific information would become irretrievable. Data recovery and resource removal and curation in an approved repository are ways in which at least some information can be salvaged should a paleontological site be affected, but invariably certain contextual data would be lost. The discovery of otherwise unknown fossils would be beneficial to science and the public good, but only as long as sufficient data can be recorded.

5.12.2 Cumulative Impacts

Paleontological resources, mainly fossils, can be affected by construction excavation for solar energy facilities. Such impacts can be mitigated by collecting or documenting fossils when encountered, with the aid of a paleontologist, or by avoiding areas rich in fossils. Many prospective solar areas have not been surveyed for paleontological resources, and the presence of fossils can be inferred only by the types of geological deposits and soils present. Such areas would be surveyed prior to facility construction.

Under the RFDS, the BLM estimates that a total combined area of approximately 700,000 acres of BLM-administered lands and 600,000 acres of other lands (including private lands and state-owned lands) across the 11-state planning area will host utility-scale PV solar energy development over the next 20 years. Solar energy development could represent a major contribution to foreseeable development because of the large acreages disturbed for construction. However, while large in size, much of the area encompassed by solar arrays would not require deep excavation and thus would not likely disturb buried resources. Foundations for PV solar arrays typically involve minor or no excavation or employ a single piling driven into the ground. Shallow to moderately deep excavations for underground utilities and electricity collector lines would be required at most facilities. Energy development on BLM-administered lands is not limited to solar energy development. The EIA projects that energy development for other renewable energy sources (e.g., wind and geothermal) will increase significantly over the next 20 years, some of which will likely be located on BLM-administered land within the 11-state planning area. Wind energy development as well as other energy and resource uses such as oil and gas leasing and development can require substantial land disturbance and have potential to contribute to cumulative impacts on paleontological resources.

Because of the vastness of the area, cumulative impacts on paleontological resources in the 11-state planning area from foreseeable development are expected to be small. The magnitude of impacts would depend on the project-specific locations of future solar energy development and their proximity to paleontological resources, as well as the adherence to mitigation measures during project planning and construction.

5.12.3 Design Features

The BLM has identified design features that will be requirements for all utility-scale solar energy projects on BLM-administered lands subject to the ROD for this Solar Programmatic EIS. The list of design features that have been identified to avoid, minimize, and/or compensate for potential impacts on paleontology from solar energy development can be found in Appendix B.12.

5.12.4 Comparison of Alternatives

To compare potential impacts from utility-scale solar energy development on paleontological resources between alternatives, the analysis compares the acres within Potential Fossil Yield Classification (PFYC) system Class 4 and Class 5 that are present within the lands available for application under each alternative. The PFYC system provides baseline guidance for assessing the relative occurrence of important paleontological resources and the need for mitigation (BLM 2016m). The classification for geologic units includes:

- Class 1 (very low)—Unlikely to contain recognizable paleontological resources.
- Class 2 (low)—Not likely to contain paleontological resources.
- Class 3 (moderate)—Fossil content varies in scientific importance, abundance, and predictable occurrence.
- Class 4 (high)—Known to have a high occurrence of paleontological resources.
- Class 5 (very high)—Consistently and predictably produce scientifically important paleontological resources.

5.12.4.1 No Action Alternative

Paleontological resources can be affected by solar energy development ROW authorizations through degradation or destruction of the resource, loss of valuable scientific information due to construction activities, and increased human access and subsequent disturbance. Under the No Action Alternative, 42,140 acres of BLM-administered lands within priority areas would be located within PFYC Class 4 or 5, while approximately 11.2 million acres of BLM-administered lands within lands available for application (variance lands in the 6 states addressed in the 2012 Western Solar Plan) would be located within PFYC Class 4 or 5. The amount of BLM-administered land classified as PFYC Class 4 and 5 represents 12.8% of land within priority areas and 24% of other lands available for solar development (Table 5.12-1). In the six states addressed under the 2012 Western Solar Plan, the design features from that plan would mitigate impacts on paleontological resources. In the five new states, required mitigation measures for these impacts would be established at the project-specific level.

5.12.4.2 Action Alternatives

Alternative 1. Under Alternative 1, approximately 10.2 million acres of BLM-administered lands within areas available for application would be located within PFYC Class 4 or 5, which represents 19% of the total lands available for application (Table 5.12-1). Solar energy development is expected to occur only on 700,000 acres (the RFDS value), or 1% of the total amount of BLM-administered lands available for solar ROW application under Alternative 1. Paleontological resources can be affected by solar energy development through degradation or destruction of the resource, loss of valuable scientific information due to construction activities, and increased human access and subsequent disturbance. Alternative 1 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria, while making all other lands available for application. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Table 5.12-1. PFYC Classes—Acreage Comparison Across Alternatives

PFYC Class	All BLM-Administered Land Intersecting PFYC (Minus DRECP/CDCA)	No Action Alternative: Intersection of PFYC with Priority Areas[a] (acres)	No Action Alternative: Intersection of PFYC with Lands Available for Application (variance lands in six state area) (acres)[b]	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
PFYC Class 1	26,516,589	41,895	8,228,544	9,147,697	4,607,344	2,190,072	892,988	572,256
PFYC Class 2	20,237,376	44,632	6,864,474	8,659,543	6,866,712	4,877,822	2,459,267	1,932,959
PFYC Class 3	25,672,356	23,988	7,183,160	8,238,993	4,215,091	2,427,197	1,364,361	919,725
PFYC Class 4	13,861,414	8,081	4,114,972	3,510,526	1,653,518	1,002,840	443,784	311,637
PFYC Class 5	19,312,657	34,059	7,128,179	6,693,571	4,048,221	2,987,571	1,768,304	1,394,072
Other (U, W, & I)	52,786,331	194,080	13,579,453	17,818,961	13,389,799	7,938,426	3,676,765	2,782,699

[a] Includes SEZs as amended, solar emphasis areas (BLM 2015a), and the Dry Lake East DLA (BLM 2019a). These total priority area in each state has been updated to reflect changes implemented since 2012 (see Section 1.3).

[b] Variance lands in six-state area.

Alternative 2. Approximately 5.7 million acres of BLM-administered lands within areas available for application would be located within PFYC Class 4 or 5, which represents 16% of the total lands available for application (Table 5.12-1). Solar energy development is expected to occur only on 700,000 acres (the RFDS value), 2% of the total amount of BLM-administered lands available for solar ROW application under Alternative 2. Paleontological resources can be affected by solar energy development through degradation or destruction of the resource and loss of valuable scientific information from construction activities and increased human access and subsequent disturbance. Alternative 2 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria. Alternative 2 applies an additional >10% slope exclusion to further limit some additional impacts, and makes all remaining lands available for application. Updated and more prescriptive design features may reduce the magnitude of impacts.

Alternative 3. Approximately 4 million acres of BLM-administered lands within areas available for application would be located within PFYC Class 4 or 5, which represents 18% of the total lands available for application (Table 5.12-1). Solar energy development is expected to occur only on 700,000 acres (the RFDS value), or 3% of the total amount of BLM-administered lands available for solar ROW application under Alternative 3. Paleontological resources can be affected by solar energy development through degradation or destruction of the resource and loss of valuable scientific information from construction activities and increased human access and subsequent disturbance. Alternative 3 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a >10% slope exclusion. Alternative 3 would also limit development to areas that are less than 10 miles from existing or planned transmission lines of >100 kV, focusing development in areas that may be more likely to be economically feasible for development. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 4. Approximately 2.2 million acres of BLM-administered lands within areas available for application would be located within PFYC Class 4 or 5, which represents 20% of the total lands available for application (Table 5.12-1). Solar energy development is expected to occur only on 700,000 acres (the RFDS value), or 6% of the total amount of BLM-administered lands available for solar ROW application under Alternative 4. Paleontological resources can be affected by solar energy development through degradation or destruction of the resource and loss of valuable scientific information from construction activities and increased human access and subsequent disturbance. Alternative 4 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria, a >10% slope exclusion, and limiting development to previously disturbed lands, limiting the area in which new land disturbance could occur. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 5. Approximately 1.7 million acres of BLM-administered lands within areas available for application would be located within PFYC Class 4 or 5, which represents 20% of the total lands available for application (Table 5.12-1). Solar energy development is expected to occur only on 700,000 acres (the RFDS value), or 8% of the total amount of BLM-administered lands available for solar ROW application under Alternative 5. Paleontological resources can be affected by solar energy development through degradation or destruction of the resource and loss of valuable scientific information from construction activities and increased human access and subsequent disturbance. Alternative 5 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria, and a >10% slope exclusion. Alternative 5 would also combine the requirement that development be limited to areas that are less than 10 miles from existing or planned transmission lines of >100 kV (from Alternative 3) with the requirement to limit development to previously disturbed lands (from Alternative 4), making it the alternative with the least lands available for solar ROW application. Alternative 5 provides a focus on areas that may be more likely to be economically feasible for development because the lands available are near the transmission grid and limit the amount of new land disturbance. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

5.13 Rangeland Resources

Direct, indirect, cumulative impacts, mitigation measures, and comparison of alternatives for rangeland resources are evaluated in two separate categories in the following subsections: Section 5.13.1 evaluates impacts on livestock grazing, and Section 5.13.2 evaluates impacts on wild horses and burros.

5.13.1 Livestock Grazing

5.13.1.1 Direct and Indirect Impacts

5.13.1.1.1 Construction and Operations

On BLM-administered lands being considered in this Solar Programmatic EIS, approximately 150 million acres (627,000 km^2) are located within grazing allotments. Although research is underway on designing PV solar energy facilities to make them compatible with grazing (DOE 2020; AGSA 2021), currently livestock grazing (particularly cattle grazing) and utility-scale solar energy generation are, for all practical purposes, largely incompatible. Until such time that cattle grazing under solar panels becomes feasible, grazing activities would likely be excluded from areas developed for utility-scale solar energy production, and the impacts (positive and negative) associated with grazing would be replaced with the impacts (positive and negative) of solar energy production. This section focuses on the adverse impacts on existing grazing operations on BLM-administered lands that would be excluded by solar energy development.

Where grazing occurs on BLM-administered lands, it is authorized either through a grazing permit or lease. The BLM grazing regulations provide that permits or leases can be cancelled or modified with a 2-year notification to the grazing permittee (43 CFR 4110.4-2(b)). All or portions of grazing permits or leases within areas developed for solar energy production could be cancelled or modified. Depending on conditions unique to an individual grazing operation, reductions in authorized grazing use may be necessary because of the loss of all or a portion of the forage base and/or range improvements (e.g., fencing, water development) supporting the grazing operation within the solar energy development area. The grazing regulations provide for reimbursement to grazing permittees for their share of the value of range improvements.

Many BLM-administered land grazing operations are made up of a combination of BLM-administered lands and privately owned lands which serve as base property. Further, permit and lease holders often possess all or portions of water rights tied to grazing operations. In many cases, state land grazing permits/leases are also held by the permittees and are integrally tied to the BLM permit. Losses of AUMs on BLM-administered lands associated with cancelling or reducing the authorized acres in a permit or lease in favor of utility-scale solar energy facilities would generally reduce the value of the affiliated private lands, the value of both BLM and state grazing permits, and in some cases, the value of affiliated water rights held by the grazing permittees. Laws and regulations do not require the mitigation of this loss of value for permittees.

Indirect impacts on livestock grazing such as loss of forage due to spread of noxious weeds and increases in occurrence of wildland fire from construction and operation activities could also occur. There could also be negative impacts on livestock distribution from noise and disturbance during each phase of project construction, which in turn could negatively affect vegetation within the allotment. With increased traffic in an allotment, there also is potential for fence gates to be left open, increasing the difficulty and cost of managing livestock.

5.13.1.1.2 Transmission Lines and Roads

Transmission line ROWs associated with solar energy facilities would not prevent the use of the land for grazing other than in the areas physically occupied by transmission towers and service roads. Construction of additional roads and increased traffic accessing solar energy development sites or transmission line roads would increase the possibility of cattle being injured or killed.

5.13.1.2 Cumulative Impacts

In 2022,17,343 permits and leases were granted for livestock grazing, with a total of about 12.2 million active AUMs on BLM-administered land in the 11-state planning area (Table 5.13.1-1). Of those, about 69% were authorized and in use (BLM 2023p). Since 1996, there has been a general downward trend in the number of permits and leases and active use of federal lands for grazing; however, the number of permits and leases authorizing use of federal lands for grazing has remained fairly consistent over the past

10 years, suggesting that federal rangelands administered by the BLM and the USFS continue to be an important part of the livestock-raising subsector of the agriculture industry.

Table 5.13.1-1. Grazing Permits, Leases, and AUMs on BLM-Administered Lands in FYs 2012 and 2022

State	FY 2012			FY 2022		
	Permits or Leases	Active AUMs[a]	Authorized AUMs	Permits or Leases	Active AUMs[a]	Authorized AUMs
Arizona	767	635,539	385,112	758	632,224	443,283
California	526	319,263	212,382	519	232,255	174,750
Colorado	1,486	589,004	359,383	1,503	582,957	275,759
Idaho	1,852	1,346,303	1,007,031	1,878	1,332,646	965,545
Montana	3,776	1,271,406	1,231,479	3,823	1,267,294	1,155,991
Nevada	693	2,144,237	1,291,610	765	2,174,857	1,167,871
New Mexico	2,271	1,849,894	1,433,721	2,191	1,848,232	1,454,166
Oregon	1,225	1,022,333	820,474	1,241	1,024,794	744,264
Utah	1,445	1,190,008	794,788	1,478	1,194,286	744,264
Washington	266	32,943	N/A	269	34,259	688,993
Wyoming	2,848	1,909,315	1,388,031	2,918	1,918,207	393,359
Total	**17,155**	**12,310,245**	**8,924,011**	**17,343**	**12,242,011**	**8,484,172**

[a] An AUM is the amount of forage needed by an "animal unit" (i.e., a mature 1,000-lb. cow and her calf) for 1 month. Active AUMs: AUMs that could be authorized on BLM-administered lands~~.~~ Source: BLM (2013e, 2023p).

Under the RFDS, the BLM estimates that a total combined area of approximately 700,000 acres of BLM-administered lands and 600,000 acres of other lands (including private lands and state-owned lands) across the 11-state planning area will host utility-scale PV solar energy development over the next 20 years. Although the acreage estimated for the RFDS is less than the acres available under any of the alternatives, livestock grazing allotments intersect or are in close proximity to 90% of the total area available for application under all of the alternatives. Since livestock grazing is generally not currently compatible with solar energy development, the direct impact of solar energy development on individual grazing permit and lease holders may be significant because solar energy development would decrease the lands available for grazing in the future, depending on the portion of individual allotments that would be replaced by solar energy development. Livestock grazing operations near, but not within, solar energy development projects may also experience indirect impacts, such as interference with access to water, or challenges in moving livestock around areas of solar energy development. Some or all of these impacts however, may be mitigated by updated design features that include efforts to site projects to minimize impacts on individual grazing allotments, and relocation of range improvements such as fencing, cattle guards, gates, pipelines, and watering facilities, where needed. Research is also underway on designing PV solar energy facilities to make them compatible with cattle grazing (see Section 5.13.1).

Local communities near the affected livestock grazing operations also would potentially experience indirect socioeconomic impacts with a project-specific range in level of significance, depending on the number of permits/leases reduced in size or cancelled to provide for solar energy development, and the relative economic importance of livestock grazing in the region.

As shown in Table 5.13.1-2, the land requirements estimated under the RFDS would only affect about 0.5% of the total grazing allotments within the 11-state planning area, although the magnitude of impacts on grazing would depend on the location of solar energy development in proximity to grazing allotments. Energy development on BLM-administered lands is not limited to solar energy development. The EIA projects that wind energy capacity in the United States will increase 177% by 2050 (EIA 2023a), some of which likely will be located on BLM-administered land within the 11-state planning area. Wind energy development as well as other energy and resource uses such as oil and gas leasing and development have potential to impact grazing as well. However, the BLM generally does not cancel a grazing lease or permit due to the more dispersed nature of these types of energy developments and because wind and geothermal energy facilities and other foreseeable development are generally more compatible with grazing. The cumulative impacts on grazing would be similar under all alternatives because the RFDS for the amount of solar energy development on BLM-administered land is the same under all alternatives. However, cumulative impacts could be less under Alternatives 3 and 5 since the transmission line exclusion would focus development near the transmission grid, potentially limiting the amount of new land disturbance within grazing lands that would otherwise be developed for transmission line interconnection.

5.13.1.3 Design Features

The BLM has identified design features that will be requirements for all utility-scale solar energy projects on BLM-administered lands subject to the ROD for this Programmatic EIS. The list of design features that have been identified to avoid, minimize, and/or compensate for potential impacts on livestock grazing from solar energy development can be found in Appendix B.13.1.

Table 5.13.1-2. Livestock Grazing Allotments—Comparison Across Alternatives

State	All BLM-Administered Land Intersecting Grazing Allotments (minus DRECP/CDCA) (acres)	No Action Alternative: Intersection of Grazing Allotments with SEZs (acres)	No Action Alternative: Intersection of Grazing Allotments with Variance Lands (acres)	Intersection of Grazing Allotments with BLM-Administered Lands Available for Application				
				Alternative 1 (acres)	Alternative 2 (acres)	Alternative 3 (acres)	Alternative 4 (acres)	Alternative 5 (acres)
Arizona	11,428,349	195,708	2,736,670	4,698,902	3,017,307	2,076,319	795,610	645,576
California	2,683,564	-	59,635	505,935	114,631	74,924	51,848	36,751
Colorado	7,742,673	22,009	116,936	2,187,990	638,184	418,239	255,196	178,103
Idaho	10,991,184	-	6,669,504	2,479,444	1,738,674	1,388,164	863,820	793,615
Montana	7,858,457	-	3,889,739	1,185,784	632,787	170,058	468,391	126,525
Nevada	43,241,134	46,202	5,955,073	16,834,373	10,861,008	5,784,300	2,034,686	1,237,424
New Mexico	12,840,123	29,716	3,861,651	6,208,856	4,791,115	2,857,977	1,683,908	1,236,673
Oregon	13,185,491	-	8,806,154	1,743,885	1,004,540	612,569	328,323	236,823
Utah	21,421,183	17,616	1,690,935	9,018,406	5,558,812	3,243,731	1,742,216	1,408,632
Washington	325,708	-	313,648	274,863	97,217	80,945	72,497	60,637
Wyoming	17,266,221	-	8,742,878	5,160,229	3,743,361	2,718,434	1,582,793	1,291,661
Westwide	148,984,087	311,251	42,842,823	50,298,666	32,197,637	19,425,660	9,879,290	7,252,420

5.13.1.4 Comparison of Alternatives

5.13.1.4.1 No Action Alternative

Some livestock grazing allotments are affected by solar energy development ROW authorizations through reductions in acreage and/or loss of AUMs. Under the No Action Alternative, approximately 310,000 acres of grazing allotments would be located within priority areas and approximately 42.8 million areas of grazing allotments would be located within lands available for application (including variance lands in the six states addressed in the 2012 Western Solar Plan). The grazing allotments within priority areas and lands available for application/variance lands represent 0.2% and 29% of the total BLM-administered lands with grazing allotments within the 11-state planning area, respectively (Table 5.13.1-2). However, solar energy development is expected to occur only on approximately 700,000 acres (the RFDS value), or 0.5% of the total grazing allotment area on BLM-administered lands within the 11-state planning area. In the six states addressed under the 2012 Western Solar Plan, the design features from that plan would mitigate livestock grazing impacts. In the five new states, required mitigation measures for livestock grazing impacts would be established at the project-specific level.

5.13.1.4.2 Action Alternatives

Alternative 1. Approximately 50.3 million acres of grazing allotments would be located within BLM-administered lands available for utility-scale solar ROW application. The grazing allotments available for solar ROW application under Alternative 1 represent 91% of the total lands available for application (Table 5.13.1-2). Assuming that the development projected under the RFDS is evenly distributed within/outside of current grazing allotments, development is expected on approximately 1% of the 50.3 million acres noted above. Some livestock grazing allotments would be affected by solar energy development ROW authorizations through reductions in acreage and/or loss of AUMs. Alternative 1 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria, while making all other lands available for application. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 2. Approximately 32.2 million acres of grazing allotments would be located within BLM-administered lands available for utility-scale solar ROW application. The grazing allotments available for solar ROW application under Alternative 2 represent 89% of the total lands available for application (Table 5.13.1-2). Assuming that the development projected under the RFDS is evenly distributed within/outside of current grazing allotments, development is expected on approximately 2% of the 32.2 million acres noted above. Some livestock grazing allotments would be affected by solar energy development ROW authorizations through reductions in acreage and/or loss of AUMs. Alternative 2 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria. Alternative 2 applies an additional 10% slope exclusion to further limit some additional impacts, and makes all remaining lands available for application. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 3. Approximately 19.4 million acres of grazing allotments would be located within BLM-administered lands available for utility-scale solar ROW application. The grazing allotments available for solar ROW application under Alternative 3 represent 88% of the total lands available for application (Table 5.13.1-2). Assuming that the development projected under the RFDS is evenly distributed within/outside of current grazing allotments, development is expected on approximately 3% of the 19.4 million acres noted above. Some livestock grazing allotments would be affected by solar energy development ROW authorizations through reductions in acreage and/or loss of AUMs. Alternative 3 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a 10% slope exclusion. Alternative 3 would also limit development to areas that are less than 10 miles from existing or planned transmission lines of >100 kV, focusing development in areas that may be more likely to be economically feasible for development. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 4. Approximately 9.9 million acres of grazing allotments would be located within BLM-administered lands available for utility-scale solar ROW application. The grazing allotments available for solar ROW application under Alternative 4 represent 88% of the total lands available for application (Table 5.13.1-2). Assuming that the development projected under the RFDS is evenly distributed within/outside of current grazing allotments, development is expected on approximately 5% of 9.9 million acres noted above. Some livestock grazing allotments would be affected by solar energy development ROW authorizations through reductions in acreage and/or loss of AUMs. Alternative 4 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria, a 10% slope exclusion, and limiting development to previously disturbed lands, limiting the area in which new land disturbance could occur. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 5. Approximately 7.3 million acres of grazing allotments would be located within BLM-administered lands available for utility-scale solar ROW application. The grazing allotment area available for solar ROW application under Alternative 5 represents 86% of the total lands available for application (Table 5.13.1-2). Assuming that the development projected under the RFDS is evenly distributed within/outside of current grazing allotments, development is expected on approximately 7% of the 7.3 million acres noted above. Some livestock grazing allotments would be affected by solar energy development ROW authorizations through reductions in acreage and/or loss of AUMs. Alternative 5 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria, and a 10% slope exclusion. Alternative 5 would also combine the requirement that development be limited to areas that are less than 10 miles from existing or planned transmission lines of >100 kV (from Alternative 3) with the requirement to limit development to previously disturbed lands (from Alternative 4), making it the alternative with the least lands available for solar ROW application. Alternative 5 provides a focus on areas that may be more likely to be economically feasible for development because the lands available are near the transmission grid and previously disturbed. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

5.13.2 Wild Horses and Burros (WH&Bs)

5.13.2.1 Direct and Indirect Impacts

The primary potential impacts on WH&B from solar energy development are those that may affect resource features (i.e., forage, water, cover, and space), individuals and populations, and the continuance of a thriving natural ecological balance, as required by the Wild Free-Roaming Horse and Burro Act of 1971, as amended. The general threshold in determining the significance of impacts on WH&B is whether or not a proposed solar energy project would result in a reduction in HMA acreage and how this could affect the AML, the point at which WH&B populations are consistent with the land's capacity to support them and other resources or mandated uses of those lands, including protecting ecological processes and habitat for wildlife. *Herd Area and Herd Management Statistics* (BLM 2023w) provides the AMLs for HMAs.

5.13.2.1.1 Site Characterization

Impacts on WH&B from site characterization activities would primarily result from disturbance (e.g., due to equipment and vehicle noise and the presence of workers and their vehicles) or from loss of forage and use areas (e.g., access road construction). Such impacts would generally be temporary and on a much smaller scale than those from project construction. Activities and noise from site characterization could force WH&B herds to change their travel routes, access to water, and grazing grounds. The magnitude and extent of the impact of these behavioral changes would depend on current land use (BLM 2016a).

5.13.2.1.2 Construction and Operations

The construction and operation of a solar energy facility could impact WH&B herds in ways similar to other large mammal species. Construction impacts include destruction and modification of resources (e.g., loss of forage and water), direct mortality (e.g., from vehicle collisions), and dust and noise impacts; while facility presence, operation, and maintenance impacts include loss and fragmentation of forage and use areas (mostly due to fencing), noise impacts, and, possibly, impacts from pollution, water consumption, fire, and lighting (Lovich and Ennen 2011).

The management of WH&B herds is not compatible with utility-scale solar energy development. Therefore, they would be excluded from areas developed for utility-scale solar energy production. Development of a solar energy project site would represent a loss of resources needed (including loss of foraging and, possibly, water sources; BLM 2016a). Avoidance of construction noise may lead to disrupted foraging and movement patterns of WH&B, particularly during the peak foaling season of March through June for horses; while fugitive dust created by construction vehicles may reduce road visibility and increase the potential that WH&Bs may be either wounded or killed by vehicle traffic. Construction may also potentially require the physical removal or relocation of WH&Bs (BLM 2016a).

Fencing is expected to keep WH&B outside of the facility location, making the project area inaccessible for grazing. Although this would represent a direct, adverse impact on an area used for grazing, the magnitude of this impact base associated with the project ROW would depend on whether more abundant and better-quality forage is available elsewhere within the HMA, and whether the population is currently within or exceeds the AML (BLM 2013d). Depending on the conditions in an individual HMA reduced in area due to solar energy development, it might be necessary to reduce the AML to match forage availability on the remaining portion of the HMA. A reduction of AML could necessitate the gathering, care, and holding of animals in excess of the revised AML. This would be subject to the requirements of the Wild Free-Roaming Horses and Burros Act of 1971, as amended, and can be a lengthy, time-consuming effort that would be subject to labor and budget constraints. Excess animals could be put up for adoption, sold (if more than 10 years old or previously passed up for adoption), or sent to federally funded off-range pastures. Also, if WH&B herds migrate outside HMA boundaries, they could also be gathered, removed, and placed in the BLM WH&B adoption program. To expand the boundaries of an HMA back into the HA would require a land use plan amendment, the cost of which could potentially be incurred by the applicant wishing to develop a solar energy facility within an HMA (BLM 2016a).

Although forage and use areas adjacent to solar energy projects (including ancillary facilities) might remain intact, WH&B may make less use of these areas (primarily because of the disturbance that would occur within the project site). This impact could be considered an indirect loss of forage and use areas. Overall, these direct and indirect losses could potentially reduce the carrying capacity within HMAs, resulting in impacts such as reduced fitness, survival, or reproduction.

Mismanaged wild horses can alter plant community composition, diversity, and structure and can increase bare ground and erosion potential. Wild horses have also been linked to negative impacts on native fauna. They have repeatedly been shown to limit and even exclude use of water sources by native wildlife (Davies and Boyd 2019). Solar energy development could contribute to these impacts, particularly if a large solar energy facility is located in a smaller HMA.

To capture a range of possible impacts of the construction and operation of individual solar energy facilities, a 5 to 750 MW range of facility capacity is presented (see Section 3.1.2). For a 750-MW facility with storage, the area of land disturbance would be about 6,000 acres (24.3 km^2). Table 5.13.2-1 provides a hypothetical example of the impact of a 750-MW solar energy facility on the smallest HMAs in each state. This example assumes that the facility could be completely located within a single HMA. Of particular note is that the AML would hypothetically decrease due to the construction and operation of a solar energy facility. For the HMA in Colorado, the wild horse population would no longer be within the AML; while the HMA in Nevada is more than three times smaller than the largest solar energy facility. However, there are 83 HMAs in Nevada of which only eight HMAs are less than 20,000 acres (80.9 km^2) in area. Since the large majority of the WH&B populations currently exceed their AMLs (BLM 2023w), reduction in the acreage of HMAs due to solar energy development would further stress WH&B populations.

Table 5.13.2-1. Hypothetical Impact of a 750-MW Solar Energy Facility on Each State's Smallest Area HMA

State	HMA Acreage		No. WH&B[a]	AML (High)	Percent Decrease in HMA from a 6,000-Acre Solar Energy Facility		Adjusted AML (High)[b]
	BLM Acres	Total Acres			BLM Area	Total Area	
AZ	60,420	83,006	970	208	9.9	7.2	193
CA	7,635	7,759	56	10	78.6	77.3	3
CO	21,043	21,395	76	80	28.5	28.0	58
ID	9,392	11,724	65	64	63.9	51.2	31
MT	27,094	35,640	205	120	22.1	16.8	112
NV	1,939	1,950	130	36	3,094	100.0[c]	0
NM	8,019	8,999	155	23	74.8	66.7	8
OR	16,279	84,963	295	50	36.9	7.1	46
UT	32,978	37,006	26	50	18.2	16.2	42
WY	19,107	24,584	258	86	31.4	24.4	65
Total	**203,906**	**417,026**	**2,236**	**727**	**2.9**	**1.4**	**558**

[a] The CO, ID, MT, NM, and WY HMAs contain only wild horses, the HMAs in the other states contain wild horses, wild burros, or both.
[b] Based on HMA total area. Calculated as AML (High) – Total Area % decrease.
[c] The hypothetical facility would encompass the entire HMA.
Source: BLM (2023w).

5.13.2.1.3 Transmission Lines and Roads

Transmission line ROWs associated with solar energy facilities would not prevent the use of the land for WH&B herds other than in the areas physically occupied by transmission towers and service roads. Construction of additional roads and increased traffic accessing solar energy development sites or transmission line roads would increase the possibility of the animals being injured or killed.

Transmission line ROWs and access road development increases the potential use of BLM-administered lands for recreation and other activities; increasing the amount of human presence increases the potential for WH&B harassment or death.

5.13.2.1.4 Decommissioning/Reclamation

The types of impacts on WH&B during decommissioning activities would be similar to those occurring during construction, and would include noise and visual disturbance. All disturbed lands would be reclaimed in accordance with BLM standards and could be available as WH&B forage and use areas unless otherwise planned. Generally, the decommissioned project area would be reclaimed to match adjacent habitat conditions.

5.13.2.2 Cumulative Impacts

Cumulative impacts on WH&B would occur when a solar energy project, along with other types of projects, are sited in current HMAs and when the combined project areas result in loss of vegetation, water supplies, HMA capacity, and the disruption of WH&B management. Under the RFDS, the BLM estimates that a total combined area of approximately 700,000 acres of BLM-administered lands and 600,000 acres of other lands (including private lands and state-owned lands) across the 11-state planning area will host utility-scale PV solar energy development over the next 20 years. The acreage estimated for the RFDS is less than the acres available under any of the alternatives and HMAs do not make up a large percentage of the total area available for application under any of the alternatives. The portion of HMAs within each alternative range from 5% under Alternative 5 to 16% under Alternative 1. It is not expected that solar energy facilities would generally be sited directly within HMAs. The magnitude of impacts on HMAs would depend on the size of the solar energy facility, the location of solar energy development in proximity to HMAs, and the size of the WH&B population relative to the AML.

Other foreseeable development could contribute additional impacts on WH&B, such as projected increases in other energy resources including wind and geothermal, and oil and gas leases and development. Existing and future mining operations and livestock grazing also have potential for impacts on WH&B resources if construction and operation of a solar energy project reduces future availability of HMAs identified within the planning area.

Design features would require protective measures for WH&B, such as the provision of movement corridors, traffic management, and fencing. Cumulative impacts on WH&B HMAs would be small overall, as would any contributions from solar energy facilities. WH&B HMAs encompass a small fraction of total available lands, and they also include lands not suitable for solar energy development because of topography and other factors, thereby reducing conflicts.

5.13.2.3 Design Features

The BLM has identified design features that will be requirements for all utility-scale solar energy projects on BLM-administered lands subject to the ROD for this Programmatic EIS. The list of design features that have been identified to avoid, minimize, and/or compensate for potential impacts on WH&B from solar energy development can be found in Appendix B.13.2.

5.13.2.4 Comparison of Alternatives

5.13.2.4.1 No Action Alternative

Some WH&B populations could be affected by solar energy development through reductions in HMA acreage. Other possible impacts include impacts on resource features (i.e., forage, water, and cover) as well as AML reductions. Under the No Action Alternative, 106 acres of HMAs would be located within priority areas, and approximately 5.6 million acres of HMAs would be located within lands available for application (including variance lands in the six states addressed in the 2012 Western Solar Plan). The HMAs within these areas represent 21.5% of the total BLM-administered lands with HMAs within the 11-state planning area (Table 5.13.2-2). However, solar energy development is expected to occur only on approximately 700,000 acres (the RFDS value), or 1.4% of BLM-administered lands available for solar ROW application. In the six states addressed under the 2012 Western Solar Plan, the design features from that plan would mitigate WH&B impacts. In the five new states, required mitigation measures for WH&B impacts would be established at the project-specific level.

5.13.2.4.2 Action Alternatives

Alternative 1. Approximately 8.9 million acres of HMAs would be located within BLM-administered lands available for utility-scale solar ROW application, which represents 16% of the total land available under Alternative 1 (Table 5.13.2-2). Some WH&B populations could be affected by solar energy development ROW authorizations through reductions in HMA acreage. Other possible impacts include impacts on resource features (i.e., forage, water, and cover) as well as AML reductions. Alternative 1 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria, while making all other lands available for application. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Table 5.13.2-2. HMAs — Acreage Comparison Across Alternatives[a]

State	All BLM-Administered Land Intersecting HMAs (minus DRECP/CDCA)	No Action Alternative: Intersection of HMAs with Priority Areas[a]	No Action Alternative: Intersection of HMAs with Lands Available for Application[c]	Intersection of HMAs with BLM-Administered Lands Available for Application				
				Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Arizona	1,435,165	—	236,507	494,464	254,642	170,112	81,484	61,762
California	433,840	—	8,518	23,764	12,713	9,195	4,616	1,369
Colorado	367,259	—	435	121,547	26,849	24,922	4,020	4,018
Idaho	377,714	—	272,915	87,804	72,617	69,239	14,219	13,236
Montana	23,540	—	8	-	-	-	-	-
Nevada	14,674,641	106	1,592,209	5,523,541	2,859,706	1,279,442	348,637	179,705
New Mexico	16,502	—	2,819	8,461	3,826	3,826	-	-
Oregon	2,712,127	—	1,549,395	173,533	141,282	69,198	23,606	18,435
Utah	2,170,367	—	330,950	1,272,832	686,811	212,879	110,280	36,011
Washington	—	—	-	-	-	-	-	-
Wyoming	3,653,052	—	1,610,543	1,182,331	954,962	552,237	281,178	181,143
Westwide	25,864,207	106	5,604,299	8,888,277	5,013,408	2,391,050	868,040	495,679

[a] Includes SEZs, solar emphasis areas (BLM 2015a), and the Dry Lake East DLA (BLM 2019a). These total priority area in each state has been updated to reflect changes implemented since 2012 (see Section 1.3).). All numbers are acres (to obtain km^2 multiply by 0.004047).

[c] Variance lands in six-state area.

Source: BLM (2023p).

Alternative 2. Approximately 5 million acres of HMAs would be located within BLM-administered lands available for utility-scale solar ROW application, which represents 14% of the total land available under Alternative 2 (Table 5.13.2-2). Some WH&B populations could be affected by solar energy development ROW authorizations through reductions in HMA acreage. Other possible impacts include impacts on resource features (i.e., forage, water, and cover) as well as AML reductions. Alternative 2 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria. Alternative 2 applies an additional 10% slope exclusion to further limit some additional impacts, and makes all remaining lands available for application. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 3. Approximately 2.4 million acres of HMAs would be located within BLM-administered lands available for utility-scale solar ROW application, which represents 29% of the total land available under Alternative 3 (Table 5.13.2-2). Some WH&B populations could be affected by solar energy development ROW authorizations through reductions in HMA acreage. Other possible impacts include impacts on resource features (i.e., forage, water, and cover) as well as AML reductions. Alternative 3 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a >10% slope exclusion. Alternative 3 would also limit development to areas that are less than 10 miles from existing or planned transmission lines of >100 kV, focusing development in areas that may be more likely to be economically feasible to develop. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 4. Approximately 870,000 acres of HMAs would be located within BLM-administered lands available for utility-scale solar ROW application, which represents 8% of the total land available under Alternative 4 (Table 5.13.2-2). Some WH&B populations could be affected by solar energy development ROW authorizations through reductions in HMA acreage. Other possible impacts include impacts on resource features (i.e., forage, water, and cover) as well as AML reductions. Alternative 4 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria, a >10% slope exclusion, and restricting development to previously disturbed lands, limiting the area in which new land disturbance could occur. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 5. Approximately 500,000 acres of HMAs would be located within BLM-administered lands available for utility-scale solar ROW application, which represents 6% of the total land available under Alternative 1 (Table 5.13.2-2). Some WH&B

populations could be affected by solar energy development ROW authorizations through reductions in HMA acreage. Other possible impacts include impacts on resource features (i.e., forage, water, and cover) as well as AML reductions. Alternative 5 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a > 10% slope exclusion. Alternative 5 would also combine the requirement that development be limited to areas that are less than 10 miles from existing or planned transmission lines of >100 kV (from Alternative 3) with the requirement to limit development to previously disturbed lands (from Alternative 4), making it the alternative with the least lands available for solar ROW application. Alternative 5 provides a focus on areas that may be more likely to be economically feasible for development because the lands available are near the transmission grid and limit the amount of new land disturbance. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

5.14 Recreation

5.14.1 Direct and Indirect Impacts

5.14.1.1 Construction and Operations

Recreational use would be excluded from all areas developed for solar energy facilities, including areas currently designated for OHV use. There may also be adverse impacts on recreational use of lands located nearby, including lands not administered by the BLM. Indirect impacts on recreational use would occur primarily on lands near the solar energy facilities and would result from the change in the overall character of undeveloped BLM-administered lands to an industrialized, developed area that would displace people who are seeking more rural or primitive surroundings for recreation. Changes to the visual landscape, impacts on vegetation, development of roads, and displacement of wildlife species resulting in reduction in recreational opportunities could degrade the recreational experience near where solar energy development occurs.

Under each of the Action Alternatives, SRMAs have been excluded from solar energy development; thus, these areas could be affected only indirectly by solar energy facilities located close to their boundaries.

Many BLM field offices have completed planning activities to designate lands for OHV use. Under these plans, areas open to application for solar energy development may be available for OHV use, and solar energy development in these areas would displace this use. ROW applications for solar energy facilities may include areas containing designated open OHV routes, thereby eliminating public access along those routes.

5.14.1.2 Transmission Lines and Roads

Transmission line ROWs would result in less impact on recreation users than solar energy facilities. Access to the land in transmission ROWs would not be precluded; however, depending on the type of recreation, the overall recreational experience could be adversely affected by the visual disturbance to the landscape, potential noise impacts associated with overhead transmission lines, and increased traffic on service roads. Transmission line service roads may provide additional opportunity for backcountry driving and/or provide new or better access to some areas; conversely, the impacts of additional road access in areas without existing roads could also lead to degradation of these areas.

5.14.2 Cumulative Impacts

Under the RFDS, the BLM estimates that a total combined area of approximately 700,000 acres of BLM-administered lands and 600,000 acres of other lands (including private lands and state-owned lands) across the 11-state planning area will host utility-scale PV solar energy development over the next 20 years. Since alternative locations for such recreation are generally abundant within the 11-state region, direct impacts from solar energy facilities on the overall availability of recreational opportunities are anticipated to be low. Future site-specific analyses of potential solar energy facilities would identify measures that would reduce anticipated impacts on local recreational use patterns and public access needs, which would further mitigate potential impacts on BLM-administered land recreational opportunities. Other renewable energy facilities could also affect areas of recreational use, as would most other types of foreseeable development in the region, including oil and gas leasing and development, mining, agriculture, and linear transmission facilities. Cumulative impacts on recreation from foreseeable development are expected to be small.

5.14.3 Design Features

The BLM has identified design features that will be requirements for all utility-scale solar energy projects on BLM-administered lands subject to the ROD for this Programmatic EIS. The list of design features that have been identified to avoid, minimize, and/or compensate for potential impacts on recreation from solar energy development can be found in Appendix B.14.

5.14.4 Comparison of Alternatives

5.14.4.1 No Action Alternative

Under the No Action Alternative, approximately 47.3 million acres of BLM-administered lands would be available for applications for solar energy development. Of the total lands available for application, 330,195 acres are located within existing priority areas, approximately 15.7 million acres are variance lands allocated in the 2012 Western Solar Plan for the six-state planning area, and approximately 31.6 million acres would be available for application within the five additional states considered in this

Programmatic EIS, as these lands were not addressed in the 2012 Western Solar Plan. Of the open available lands, under the RFDS the BLM estimates that approximately 700,000 acres (1.4%) of BLM-administered lands will host utility-scale PV solar energy development over the next 20 years. Within the five states not addressed in the 2012 Western Solar Plan, all BLM-administered lands (including SRMAs) would be available for application for solar energy development, after application of any exclusions specified in applicable land use plans. Recreational use would be excluded from all areas developed for solar energy facilities. Because SRMAs are not excluded from development within the five new states addressed under the No Action Alternative, impacts on recreation could be greater than under the Action Alternatives, depending on the specific location of solar energy development projects. In the six states addressed under the 2012 Western Solar Plan, the design features from that plan would mitigate recreation impacts. In the five new states, required mitigation measures for recreation impacts would be established at the project-specific level.

5.14.4.2 Action Alternatives

Alternative 1. Approximately 55 million acres of BLM-administered lands would be available for utility-scale solar ROW application; however, the RFDS estimates that solar energy development would occur only on approximately 700,000 acres, which is about 1% of the BLM-administered lands available for solar ROW application under Alternative 1. Recreational use would be excluded from all areas developed for solar energy facilities, although SRMAs are excluded from solar energy development under this and all Action Alternatives. Alternative 1 would help the BLM to meet its energy goals by focusing development into areas that avoid resource conflicts through resource-based exclusion criteria, while making all other lands available for application. Alternative 1 would make more lands available for application than are currently available under the No Action Alternative. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 2. Approximately 36.2 million acres of BLM-administered lands would be available for utility-scale ROW application; however, the RFDS estimates that solar energy development would occur only on approximately 700,000 acres, which is about 2% of the BLM-administered lands available for solar ROW application under Alternative 2. Recreational use would be excluded from all areas developed for solar energy facilities, although SRMAs are excluded from solar energy development under this and all Action Alternatives. Alternative 2 would help the BLM to meet its energy goals by focusing development into areas that avoid resource conflicts through resource-based exclusion criteria and a >10% slope exclusion. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 3. Approximately 22.2 million acres of BLM-administered lands would be available for utility-scale solar ROW application; however, the RFDS estimates that solar energy development would occur only on approximately 700,000 acres, which is about 3% of the BLM-administered lands available for solar ROW application under Alternative 3. Recreational use would be excluded from all areas developed for solar energy facilities, although SRMAs are excluded from solar energy development under this and all Action Alternatives. Alternative 3 would help the BLM to meet its energy goals by focusing development into areas that avoid resource conflicts through resource-based exclusion and a >10% slope exclusion. Alternative 3 would also limit development to areas that are less than 10 miles from existing or planned transmission lines of >100 kV, focusing development in areas that may be more likely to be economically feasible for development. Depending on the specific location of future solar energy development, less available acreage could result in avoiding areas where people recreate and could create less land disturbance; while access to lands developed for transmission line ROWs would not be precluded, the recreational experience could be adversely affected from the development of additional transmission lines. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 4. Approximately 11.2 million acres of BLM-administered lands would be available for utility-scale solar ROW application; however, the RFDS estimates that solar energy development would occur only on approximately 700,000 acres, which is about 6% of the BLM-administered lands available for solar ROW application under Alternative 4. Recreational use would be excluded from all areas developed for solar energy facilities, although SRMAs are excluded from solar energy development under this and all Action Alternatives. Alternative 4 would help the BLM to meet its energy goals by focusing development into areas that avoid resource conflicts through resource-based exclusion criteria and a >10% slope exclusion, and limiting development to previously disturbed lands, limiting the area in which new land disturbance could occur. Depending on the specific location of future solar energy development, the exclusion of more intact land reduces available acreage and could result in avoiding areas where people are more likely to recreate. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 5. Approximately 8.4 million acres of BLM-administered lands would be available for utility-scale solar ROW application; however, the RFDS estimates that solar energy development would occur only on approximately 700,000 acres, which is about 8% of the BLM-administered lands available for solar ROW application under Alternative 5. Recreational use would be excluded from all areas developed for solar energy facilities, although SRMAs are excluded from solar energy development under this and all Action Alternatives. Alternative 5 would help the BLM to meet its energy goals by focusing development into areas that avoid resource conflicts through resource-based exclusion criteria and a >10% slope exclusion. Alternative 5 would also combine the requirement that development be limited to areas that are less than

10 miles from existing or planned transmission lines of >100 kV (from Alternative 3) with the requirement to limit development to previously disturbed lands (from Alternative 4), making it the alternative with the least lands available for solar ROW application. Alternative 5 provides a focus on areas that may be more likely to be economically feasible for development because the lands available are near the transmission grid and limit the amount of new land disturbance. While access to lands developed for transmission line ROWs would not be precluded from recreation, the recreational experience could be adversely affected from the development of additional transmission lines. Depending on the specific location of future solar energy development, limiting development to previously disturbed lands reduces available acreage and could result in avoiding less disturbed areas where people recreate. While access to lands developed for transmission line ROWs would not be precluded from recreation, the recreational experience could be adversely affected from the development of additional transmission lines, Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

5.15 Socioeconomics

5.15.1 Direct and Indirect Impacts

The economic impact of solar energy developments was assessed at the state level for the 11-state planning area.[10] Impacts were measured in terms of employment, earnings, state tax revenues (sales and income), population in-migration, vacant rental housing, and local government expenditures and employment. Recreation impacts are considered in Section 5.15.4, impacts on property values in Section 5.15.5, impacts on amenities and economic development in Section 5.15.6, and social impacts in Section 5.15.7.

To calculate economic impacts, the assessment used the Jobs and Economic Development Impacts (JEDI) model developed by NREL (2023b). The model uses representative industry data on PV facility direct construction and operating costs, including the impacts on PV technology component and operating equipment manufacturing industries in each state, and uses economic data from the Economic Impact Analysis for Planning (IMPLAN) model to estimate the indirect impacts associated with solar energy project wage and salary spending and material procurement spending. Direct employment data from the JEDI model were used to estimate sales and income taxes, and the number of temporary in-migrants into each state during construction, and impacts on the rental housing market, local and state government expenditures, and employment.

To capture a range of possible impacts of the construction and operation of individual solar energy facilities, a 5 to 750 MW range of facility capacity is presented (see

[10] Local opposition to solar projects has been forthcoming. See, for example, Eisenson (2023) and Johnson (2023).

Section 3.1.2). Assumptions used in the JEDI model produce impacts that are proportional to solar energy facility capacity. Based on construction schedules at existing and proposed solar energy facilities (BLM 2011b, 2018a, 2019c, 2021a), construction impacts were assumed to occur over a 3-year period for the 750-MW power plant, and in a 1-year period for the 5-MW facility. Impacts were assessed for the first year of a multiple-year operation.

Impacts of solar energy developments vary across the 11 states due to slight differences in direct construction labor required to build solar energy facilities in each state, and to variations in the size of the indirect impacts. These variations result from differences in the amount of construction and operation expenditures retained in each state, which in turn depend on whether the industries required to provide materials and services to solar energy projects are present in each state, and the extent to which expenditures have to be made in other states.

Although the analysis presents impacts based on a range of facility sizes, project-level NEPA analyses to determine the local impacts of individual facilities, especially those located in small rural communities, would be needed, as the extent of local worker hiring and material procurement, in-migration and housing requirements related to any given project are not known.

5.15.1.1 Construction

Total employment impacts of a solar energy facility (including direct and indirect impacts) would be largest in Montana, where a 750-MW facility would create 1,776 new jobs and a 5-MW facility would create 36 new jobs (Table 5.15.1-1); between 35 and 1,736 new jobs would be created in Idaho; between 33 and 1,661 new jobs in Oregon; and between 33 and 1,642 new jobs in Utah. Slightly smaller impacts would occur in the other seven states. Construction activities for the 750MW facility would constitute less than 0.5 % of total state employment in each of the 11 states. Solar energy development employment would produce larger earnings impacts in Colorado (between $1.7 million and $87.0 million), Oregon ($1.7 million to $86.3 million), and California ($1.7 million to $84.4 million), with slightly smaller impacts elsewhere.

Fiscal impacts of a solar energy facility would include impacts on state sales taxes and, where applicable, income taxes. Sales tax increases would range between $0.1 million and $5.7 million in Montana for a 5- and 750-MW facility, respectively, with slightly smaller increases in the other 10 states; income tax increases would be between $0.1 million and $4.1 million in Montana, with slightly smaller increases in the remaining states with income taxes. Although energy developments on BLM-administered lands are often exempt from property taxes, some utility-scale solar energy developments on BLM-administered lands pay property taxes.[11] Other state and local revenues include those from user fees, permit fees, and payments in lieu of taxes (PILT) used to support local and state public services provided in communities in the vicinity of these facilities.

[11] It was proposed that the Silver State Solar Power North facility, located on federal land near Primm in Clark County, pay property taxes (State of Nevada 2011).

The size and combination of taxes and payments made by solar energy facilities on federal lands would be the result of negotiation between solar developers and state and federal agencies. These taxes and payments could be larger than the sales and income taxes generated by solar energy facilities. Loss of grazing AUMs on land used for solar facilities could also affect local community economies. There is also concern that the rapid pace of solar facility construction would mean that there are adverse fiscal impacts on local government finances as increases in local government services and facility expansion are required during the early phases of construction before the benefits of tax revenues from solar energy developments begin to occur.

Given the scale of construction activities and the likelihood of low local worker availability in the required occupational categories, construction of a solar energy facility would mean that some temporary in-migration of workers from outside each state would be required, with about 3 to 129 persons in-migrating temporarily into Montana during construction for a 5- and 750-MW facility, respectively; and slightly fewer in each of the other 10 states (Table 5.15.1-1). Although in migration may potentially affect local housing markets, the relatively small number of in-migrants and the availability of temporary accommodations (hotels, motels, and mobile home parks) would mean that the impact of solar energy facility construction on the number of vacant rental housing units is not expected to be large, with less than 1% of available rental units expected to be occupied by solar workers in the majority of the 11 states, and about 1.3% in Wyoming.

Table 5.15.1-1. Socioeconomic Impacts of Construction of Solar Facilities[a]

State	Min./ Max.	Employment (no.)		Earnings ($m 2022)	State taxes ($m 2022)		In-migrants (no.)	Vacant rental housing[b]	Local government	
		Direct	Total		Sales	Income			Expenditures[c]	Employment (no.)
Arizona	Min.	16	31	1.6	0.1	0.1	2	0.00%	0.00%	0
	Max.	2,460	4,619	245.1	17.1	12.3	369	0.30%	0.00%	15
California	Min.	15	27	1.7	0.1	0.1	2	0.00%	0.00%	0
	Max.	2,254	4,004	253.1	18.9	12.7	338	0.10%	0.00%	16
Colorado	Min.	16	30	1.7	0.1	0.1	2	0.00%	0.00%	0
	Max.	2,357	4,560	260.1	18.4	13	353	0.50%	0.00%	19
Idaho	Min.	17	35	1.6	0.1	0.1	3	0.00%	0.00%	0
	Max.	2,581	5,209	241.6	17.1	12.1	387	1.80%	0.00%	18
Montana	Min.	17	36	1.6	0.1	0.1	3	0.00%	0.00%	0
	Max.	2,587	5,327	245.3	17.1	12.3	388	1.90%	0.00%	21
Nevada	Min.	17	30	1.6	0.1	n/a[b]	2	0.00%	0.00%	0
	Max.	2,468	4,569	238.3	17.4	n/a[b]	370	0.80%	0.00%	14
New Mexico	Min.	16	32	1.6	0.1	0.1	2	0.00%	0.00%	0
	Max.	2,428	4,820	235.3	17.3	11.8	364	1.00%	0.00%	21
Oregon	Min.	16	33	1.7	0.1	0.1	2	0.00%	0.00%	0
	Max.	2,467	4,982	259	18.5	12.9	370	0.8	0.00%	18
Utah	Min.	17	33	1.7	0.1	0.1	3	0.00%	0.00%	0
	Max.	2,556	4,927	256.3	17.9	12.8	383	1.40%	0.00%	19
Washington	Min.	15	26	1.6	0.1	n/a[b]	2	0.00%	0.00%	0
	Max.	2,312	3,868	241.6	18.2	n/a[b]	347	0.40%	0.00%	18
Wyoming	Min.	17	29	1.4	0.1	n/a[b]	3	0.00%	0.00%	0
	Max.	2,564	4,341	205.4	14.6	n/a[b]	385	3.90%	0.00%	33

[a] The minimum facility size for a solar facility was assumed to be 5 MW; the maximum facility size was assumed to be 750 MW.
[b] Percent of the total number of vacant rental housing units in the state.
[c] Percent of total state and local government expenditures in the state.
[d] n/a = not applicable. There are currently no state income taxes in Nevada, Washington, and Wyoming.

In addition to the potential impact on housing markets, in-migration would have minor impacts on state and local government expenditures and employment, with an increase of less than 0.1% in expenditures expected in Montana, and with smaller increases elsewhere in the 11 states to meet the existing levels of service in providing state and local government services (Table 5.15.1-1). Increases in total employment, and in firefighters and uniformed police officers would be expected to maintain levels of service for government services, with up to 21 new employees likely to be required in Montana and slightly fewer in the other states. These increases would represent less than 0.1% of state and local employment in each of the 11 states in 2021.

5.15.1.2 Operations and Maintenance

Total employment impacts of the operation of a solar energy facility (including direct and indirect impacts) would be largest in Montana, where between 1 and 233 new jobs would be created for a 5- and 750-MW facility, respectively, with slightly smaller impacts occurring in Idaho (between 2 and 232 new jobs created) and in New Mexico (up to new 224 jobs; Table 5.15.1-2). A solar energy development would produce larger earnings impacts in Colorado (between $0.1 million and $13.0 million), with slightly smaller impacts in Oregon, Utah, and the other eight states. The fiscal impacts of a solar energy facility would include state sales and, where applicable, income taxes, amounting to up to $0.8 million in sales taxes and up to $0.7 million in income taxes, where applicable, in the remainder of the 11 states.

Table 5.15.1-2. Socioeconomic Impacts of Operation of Solar Facilities[a]

State	Min./ Max.	Employment (no.)		Earnings ($m 2022)	State taxes ($m 2022)	
		Direct	Total		Sales	Income
Arizona	Min.	1	1	0.1	<0.1	<0.1
	Max.	139	216	12.5	0.8	0.6
California	Min.	1	1	0.1	<0.1	<0.1
	Max.	139	199	12.4	0.8	0.6
Colorado	Min.	1	1	0.1	<0.1	<0.1
	Max.	139	218	13	0.8	0.7
Idaho	Min.	1	2	0.1	<0.1	<0.1
	Max.	139	232	12.4	0.8	0.6
Montana	Min.	1	1	0.1	<0.1	<0.1
	Max.	139	233	12.4	0.8	0.6
Nevada	Min.	1	1	0.1	<0.1	n/a[b]
	Max.	139	210	12	0.8	n/a[b]
New Mexico	Min.	1	1	0.1	<0.1	<0.1
	Max.	139	224	12.1	0.8	0.6
Oregon	Min.	1	1	0.1	<0.1	<0.1
	Max.	139	223	12.8	0.8	0.6
Utah	Min.	1	1	0.1	<0.1	<0.1
	Max.	139	222	12.6	0.8	0.6
Washington	Min.	1	1	0.1	<0.1	n/a[b]
	Max.	139	195	12.3	0.8	n/a[b]
Wyoming	Min.	1	1	0.1	<0.1	n/a[b]
	Max.	139	198	11	0.7	n/a[b]

[a] The minimum facility size for a solar facility was assumed to be 5 MW; the maximum facility size was assumed to be 750 MW.

[b] n/a = not applicable. There are currently no state income taxes in Nevada, Washington and Wyoming.

With a relatively small local labor force required to maintain and operate solar energy facilities, no in-migrants are expected with either facility size. No impacts are likely in the rental housing market or in local government expenditures or employment.

5.15.1.3 Transmission Lines

In addition to impacts of construction and operation of a solar energy facility, there would also be impacts from the construction and operation of transmission lines connecting solar energy facilities with the existing power grid. Although these impacts would not be as large as those of solar power plants, transmission line construction would create temporary jobs and earnings in the economies of local communities, notably in construction, transportation, retail, food, and lodging (Collins and Hladik 2017). Construction activities requiring temporary migrant workers may also affect rental housing rates and availability.

5.15.1.4 Recreation

Concerns exist that solar energy development may affect recreation in the vicinity of solar energy facilities. Estimating these impacts is problematic, however, because it is not clear how individual solar energy facilities in each state would affect recreational visitation and visitor spending, and nonmarket values (the value of recreational resources for potential or future visits; Springer and Daue 2020). While it is clear that some land in each state would be no longer accessible for recreation, the majority of popular wilderness locations, and other BLM-administered lands such as WSAs (wilderness study areas), SRMAs, LWCs, ACECs, and National Monuments and National Conservation Areas (see Section 5.16.1.1) would be precluded from solar energy development. It is also possible that solar energy developments in each state would be visible from popular recreation locations, possibly reducing visitation and consequently affecting the economy of each state.

5.15.1.5 Property Values

Solar energy developments and their associated transmission lines might affect property values in nearby communities. Property values might decline in some locations as a result of the deterioration in aesthetic quality, real or perceived health impacts, congestion, or social disruption (BLM 2011c; Elmallah et al. 2023). Many of these impacts are likely to be local and temporary, related to distance of housing from solar projects, and often associated with announcements related to specific project phases, such as site selection, the start of construction, or the start of operations. At larger distances, over longer time periods, smaller and less enduring negative property value impacts may occur. In other locations, property values might increase because of access to employment opportunities associated with solar energy developments, and through increases in demand for local housing (Elmallah et al. 2023). Although property values could increase if solar energy developments provide a significant source of employment, larger-scale development, rapid increases in population and the associated congestion in the absence of adequate infrastructure investment and appropriate local community planning might have adverse impacts on property values.

This is particularly important when the rapid pace in solar facility construction may mean that there are adverse fiscal impacts on local government finances before any benefits of tax revenues from solar energy developments begin to occur.

Energy transmission lines could also affect property values in communities located on land adjacent to solar energy developments, primarily as a result of the impact of electricity transmission structures on visual resources (see Section 5.19.1); real or perceived health and safety issues (in particular, concerns regarding exposure to electromagnetic frequency radiation); and noise (Tatos et al. 2020). The size of these impacts would depend on the extent and location of new transmission line structures, particularly proximity to local communities.

5.15.1.6 Environmental Amenities and Economic Development

Solar energy development may affect environmental amenities, including environmental quality, stable rural community values, or cultural values (BLM 2011c). Consequently, some local communities near utility-scale solar energy developments may have difficulty in attracting businesses that are highly sensitive to actual or perceived changes in environmental amenities. Over recent decades, many areas of the western United States have diversified their economies away from largely extractive industries toward knowledge-based industries; the professional and service sectors; and retirement, recreation, and tourism. These economic sectors tend to be more sensitive to changes in environmental amenities. Although changes in the cost and availability of local labor resources, housing costs, the provision of education and health services, and the prevailing relative cost of doing business, each of which may accompany diversification away from extractive industries may be more important than environmental amenities to some sectors, perceived deterioration in the natural environment and in amenities in particular locations may have an important impact on the ability of communities in adjacent areas to foster sustainable economic growth. Larger solar energy developments and longer transmission lines, especially if development is located within visibility of popular recreation areas, local communities, and local highways, could have detrimental impacts on economic development in each state.

5.15.1.7 Social Change and Disruption

There is concern that rapid population growth in smaller rural communities could lead to social change, social disruption, and a breakdown in social structures, with a consequent increase in alcoholism, depression, suicide, social conflict, divorce, delinquency; a change in one's sense of place; and a deterioration in levels of community satisfaction (BLM 1980, 1983, , 2011c). The resulting deterioration in local quality of life may also potentially adversely affect property values.

While in overall terms, the in-migration of workers into each state would represent a relatively small increase in state population during construction and operation of solar energy facilities, it is possible that some construction workers will choose to locate in communities closer to each solar energy development, reducing vacancy rates and raising rental rates, which may disproportionately impact low-income populations, potentially severing community ties if low-income populations are permanently displaced. However, the lack of available housing in smaller rural communities to accommodate all temporarily in-migrating workers in each state and an insufficient range of housing choices to suit all solar occupations may mean many workers are likely to commute to the solar energy development from larger communities elsewhere, reducing the potential impact of solar energy developments on social change.

Regardless of the pace of population growth associated with solar energy development, with larger or multiple solar energy facilities, the number of new residents from outside smaller communities is likely to lead to some demographic and social change in small rural communities. Communities hosting these developments may likely be required to adapt to a different quality of life, with a transition away from a more traditional lifestyle involving ranching and agriculture (taking place in small, isolated, close-knit homogenous communities with a strong orientation toward personal and family relationships) toward a more urban lifestyle, with increasing cultural and ethnic diversity and increasing dependence on formal social relationships within the community.

5.15.1.8 Decommissioning

Compared to during construction, a similar number or slightly fewer employees are likely to be required during decommissioning and reclamation activities to complete facility removal activities in a slightly shorter period of time. Additionally, decommissioning work may not require the same level of experience or skills as for project construction, resulting in lower earnings. Decommissioning is expected to temporarily decrease unemployment and increase earnings in the communities near solar energy facilities. No impacts on housing or public services would be expected to occur.

5.15.2 Cumulative Impacts

Under the RFDS, the BLM estimates that a total combined area of approximately 700,000 acres of BLM-administered lands and 600,000 acres of other lands (including private lands and state-owned lands) across the 11-state planning area will host utility-scale PV solar energy development over the next 20 years. This corresponds to approximately 100,000 MW of solar energy generation on BLM-administered lands in the 11-state planning area (see Section 2.2). The corresponding total number of annual construction jobs created would range from approximately 1,800 in Montana to 58,000 in Arizona, and the number of permanent operations jobs would range from about 240 to 8,200 in the same states. The total income estimated to result from solar energy development under the RFDS would also vary by state. In Nevada, for example, estimated annual construction income would be $728 million, with $110 million in annual income from operations. Construction income would be realized over an assumed development period of 20 years (approximately through 2045), while operations income would be ongoing. These estimates would almost double when including an estimated additional 87,000 MW of solar energy generation on non-BLM-administered lands in the planning area.

As a point of comparison, the total employment in Nevada in 2021 was 1.4 million, so new construction employment from solar energy development on BLM-administered lands in the state over the 20-year period would be a small percentage of total state employment, roughly 1.0%. However, for all the states, the economic impact would occur in areas of low population, resulting in relatively larger local economic benefits. The relatively small operations workforce at individual solar projects would not be expected to strain local services or cause significant social impacts in communities. During the build-out phase, however, large numbers of construction workers might cause temporary social disruption in small communities.

Other foreseeable development in the 11-state region could contribute to cumulative social and economic impacts. Depending on location, other types of energy development including oil and gas development as well as geothermal and wind energy development could change the social and economic conditions of local communities. Cumulative social impacts for all development would likely be minor, due to the slow pace of other types of development in the rural areas that may be used for solar and other renewable energy development as well as the large areas of BLM-administered lands available for future development to occur. However, the overall cumulative economic activity related to general development in the planning area would benefit the economies of any of the affected localities.

5.15.3 Design Features

The BLM has identified design features that will be requirements for all utility-scale solar energy projects on BLM-administered lands subject to the ROD for this Programmatic EIS. The list of design features that have been identified to avoid, minimize, and/or compensate for potential impacts on socioeconomics from solar energy development can be found in Appendix B.15.

5.15.4 Comparison of Alternatives

5.15.4.1 No Action Alternative

Under the No Action Alternative, approximately 47.3 million acres of BLM-administered lands would be available for applications for solar energy development. Of the total BLM-administered lands available for application, 330,195 acres are located within existing priority areas, approximately 15.7 million acres are variance lands allocated in the 2012 Western Solar Plan for the six-state planning area, and approximately 31.6 million acres would be available for application within the five additional states considered in this Programmatic EIS, as these lands were not addressed in the 2012 Western Solar Plan. However, solar energy development is expected to occur only on approximately 700,000 acres (the RFDS value), or 1.4% of BLM-administered lands available for solar ROW application under the No Action Alternative. Socioeconomic impacts described in Section 5.15.1 could occur from the construction and operation of PV solar energy facilities under the No Action Alternative. In the six states addressed under the 2012 Western Solar Plan, the design features from that plan would mitigate adverse socioeconomic impacts. In the five new states, required mitigation measures for socioeconomic impacts would be established at the project-specific level.

5.15.4.2 Action Alternatives

Alternative 1. Approximately 55 million acres of BLM-administered lands would be available for utility-scale solar application. The RFDS assumes that solar energy development would be limited to approximately 700,000 acres, which is about 1% of the lands available for application under Alternative 1. Alternative 1 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and would also allow more lands available for application than under the No Action Alternative. The magnitude of impacts on socioeconomics would depend on the location of solar energy development and proximity to population centers. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 2. Approximately 36.2 million acres of BLM-administered lands would be available for utility-scale solar application. The RFDS assumes that solar energy development would be limited to approximately 700,000 acres, which is about 2% of the BLM-administered lands available for application under Alternative 2. Alternative 2 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based and a >10% slope exclusion. The magnitude of impacts on socioeconomics would depend on the location of solar energy development and proximity to population centers. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 3. Approximately 22.2 million acres of BLM-administered lands would be available for utility-scale solar application. The RFDS assumes that solar energy development would be limited to approximately 700,000 acres, which is about 3% of the BLM-administered lands available for application under Alternative 3. Alternative 3 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a >10% slope exclusion. Alternative 3 would also limit development to areas that are less than 10 miles from existing or planned transmission lines of >100 kV, decreasing the amount of land available for solar energy development. Limiting development to BLM-administered lands within 10 miles of existing or planned transmission lines may result in socioeconomic impacts by focusing utility-scale solar energy development into areas closer to existing transmission and therefore likely closer to population centers. Although this may concentrate employment and income benefits in a smaller number of local communities, where these communities are small, there would likely be higher demands on local infrastructure, rental housing, and local public services, and could lead to social disruption and social change. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action

Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 4. Approximately 11.2 million acres of BLM-administered lands would be available for utility-scale solar application. The RFDS assumes that solar energy development would be limited to approximately 700,000 acres, which is about 6% of the BLM-administered lands available for application under Alternative 4. Alternative 4 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a >10% slope exclusion, and limiting development to previously disturbed lands. Limiting development to previously disturbed lands may result in socioeconomic impacts by focusing utility-scale solar energy development into areas which may be closer to population centers. Although this may concentrate employment and income benefits in a smaller number of local communities, where these communities are small, there would likely be higher demands on local infrastructure, rental housing, and local public services, and could lead to social disruption and social change. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 5. Approximately 8.4 million acres of BLM-administered lands would be available for utility-scale solar application. The RFDS assumes that solar energy development would be limited to approximately 700,000 acres, which is about 8% of the BLM-administered lands available for application under Alternative 5. Alternative 5 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a >10% slope exclusion. Alternative 5 would also combine the requirement that development be limited to areas that are less than 10 miles from existing or planned transmission lines of >100 kV (from Alternative 3) with the requirement to limit development to previously disturbed lands (from Alternative 4), making it the alternative with the least lands available for solar ROW application. Alternative 5 provides a focus on areas that may be more likely to be economically feasible for development because the lands available are near the transmission grid and limit the amount of new land disturbance. Limiting solar energy development to BLM-administered lands near existing or planned transmission lines and previously disturbed lands may result in socioeconomic impacts by focusing utility-scale solar energy development into areas closer to existing transmission and therefore likely closer to population centers. Although this may concentrate employment and income benefits in a smaller number of local communities, where these communities are small, there would likely be higher demands on local infrastructure, rental housing, and local public services, and could lead to social disruption and social change. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

5.16 Specially Designated Areas and Lands with Wilderness Characteristics

5.16.1 Direct and Indirect Impacts

Significant impacts on specially designated areas and lands with wilderness characteristics (LWCs) could occur if the solar project conflicts with the goals, objectives, and resources that a particular area is intended to protect or with the desired future conditions for the areas.

5.16.1.1 Construction and Operations

Under all Action Alternatives, national conservation lands (NCLs) and ACECs (special designations) are excluded from solar energy facilities are not compatible with the purpose for these special designations. These areas contain outstanding cultural, ecological, scientific, and/or other values which are recognized by Congress, the president, and/or the BLM through special designation. Categories of NCLs include wilderness areas (WAs), WSAs, national conservation areas (NCAs), national monuments, wild and scenic rivers (WSRs, including segments of rivers determined to be eligible or suitable for WSR status identified in applicable land use plans), and national scenic and historic trails (NSHTs, including trails recommended as suitable for designation through a congressionally authorized National Trail Feasibility Study pending the outcome of the study). ACECs are designated at the BLM field office level through the BLM's land use planning process to protect the identified values within these areas. Also excluded are national recreation, water, or side and connecting trails and BLM-designated back country byways. In addition, all areas for which an applicable land use plan establishes protection for research natural areas (RNAs) and LWCs with a land use plan decision to prioritize protection of wilderness are also excluded from solar energy development under all alternatives analyzed in this Solar Programmatic EIS.

However, the above-mentioned areas could be indirectly affected by development of utility-scale solar energy development on BLM-administered lands adjacent to or near these areas. Indirect impacts could also occur in areas proposed by citizens' groups for wilderness designation; and areas managed or designated by other federal, state, and local agencies (e.g., national park and national refuge systems and state parks).

During construction, indirect impacts on visitor experience in these specially designated areas and LWCs could occur from fugitive dust, visual disturbance, noise, and lighting, which could reduce opportunities for solitude or outstanding opportunities for primitive and unconfined types of recreation (see Sections 5.2, 5.14, and 5.19). Additionally, route or area closures during construction could affect access to specially designated areas and LWCs.

The overall size of the solar energy facility could influence these indirect impacts. All things being equal, indirect impacts would be highest for larger solar energy facilities

(6,000 acres [24.3 km^2] for a 750-MW PV facility with storage or about 5,250 acres [21.2 km^2] for one without storage) and least for smaller solar energy facilities (40 acres [0.16 km^2] for a 5-MW PV facility with storage or 35 acres [0.14 km^2] for one without storage).

Similarly, utility-scale solar energy development activities adjacent to or near LWCs and citizen's proposed wilderness areas could adversely affect or eliminate the wilderness characteristics in portions of these areas by affecting their naturalness (i.e., visual impacts) or opportunities for solitude or primitive and unconfined recreation.

Even with implementation of mitigation measures, a project could adversely affect the solitude/remoteness of these areas by introducing unnatural visual elements into the landscape, the indirect impacts of which cannot be avoided. This could impede the BLM's ability to manage and protect WSAs in a manner that does not impair the suitability of the WSAs for preservation as wilderness until Congress either designates the area as wilderness or releases it from further wilderness consideration.

5.16.1.2 Transmission Lines and Roads

While the Solar Programmatic EIS considers the impacts of constructing, operating, and decommissioning the related infrastructure needed to support utility-scale solar energy development, such as transmission lines and access roads, the land use plan decisions to be will be applicable only to utility-scale solar energy generation facilities. Management decisions for supporting infrastructure would continue to be made in accordance with existing land use plan decisions and current applicable policy and procedures. The siting of supporting infrastructure would be fully analyzed in project-specific environmental reviews in accordance with NEPA. Such reviews would be completed in combination with solar generation facility environmental reviews as appropriate.

5.16.1.3 Decommissioning

The impacts from decommissioning of the project would be similar to those associated with construction, but would include demolition and removal of above-ground and subsurface facilities and site contouring and restoration. However, the duration of decommissioning would be shorter than the duration of construction. Decommissioning activities could cause temporary disturbance to users of nearby specially designated areas or LWCs. All disturbed lands would be reclaimed in accordance with BLM standards. Due to the extensive soil and ground alteration involved with the project, particularly for larger facilities, restoring native vegetation and wildlife, natural drainages, and other features that contribute to the setting of any nearby specially designated areas and LWCs could take decades. Nevertheless, impacts of the project on the setting would be reduced by decommissioning, as the incompatible man-made elements of the project would be removed. Unless preexisting conditions are completely reestablished, indirect impacts on specially designated areas and LWCs resulting from construction and operation would continue to some extent.

5.16.2 Cumulative Impacts

Specially designated areas and LWCs (for which an applicable land use plan establishes their protection of wilderness values) are exclusion areas for PV solar energy development on BLM-administered lands, although associated transmission lines and access roads could intersect areas such as NSHTs; in which case the proliferation of ROWs and roads may detract from the recreational or historic setting of the specially designated area. Thus, potential impacts of solar energy facilities on these sensitive areas include visual impacts, reduced access, and, mainly during construction, noise, and fugitive dust.

Under the RFDS, the BLM estimates that a total combined area of approximately 700,000 acres of BLM-administered lands and 600,000 acres of other lands (including private lands and state-owned lands) across the 11-state planning area will host utility-scale PV solar energy development over the next 20 years. The RFDS land-use projections would affect a relatively small proportion of total BLM-administered lands in the planning area, however, potential cumulative impacts could occur over the entire 11-state planning period from the initiation of construction of facilities through facility closures and site restorations. Multiple project impacts could reduce the value of the nearby specially designation areas and LWCs and reduce opportunities for solitude, naturalness, and unconfined recreation within these areas; and may lead to an increase in use of specially designated areas and LWCs located further away.

Incremental impacts on specially designated areas and LWCs being managed for their wilderness values resulting from solar energy development could combine with the incremental impacts of past, present, or reasonably foreseeable future actions to cause or contribute to a cumulative impact. Cumulative impacts on specially designated areas and LWCs could occur from increased development and visual clutter in general in the surrounding areas, reduced local and regional visibility due to construction-related air particulates, light pollution (including glare), and road traffic. Renewable energy development is the major foreseeable contributor to cumulative impacts on specially designated areas and LWCs, with solar energy the primary contributor in many areas. Other future developments that could affect these areas include oil and gas development, OHV use, military and civilian aviation, and new transmission lines and other linear facilities. Most such developments would affect the viewshed and would produce fugitive dust emissions during construction, while mining and aviation would also have noise and vibration impacts. Several design features required under the Action Alternatives would minimize the impacts from solar energy development, including (1) siting solar energy facilities as far as possible from key observation points and (2) limiting fugitive dust generation during construction through BMPs and proper timing of work.

5.16.3 Design Features

The BLM has identified design features that will be requirements for all utility-scale solar energy projects on BLM-administered lands subject to the ROD for this Programmatic EIS. The list of design features that have been identified to avoid,

minimize, and/or compensate for potential impacts on specially designated areas and LWC from solar energy development can be found in Appendix B.16.

5.16.4 Comparison of Alternatives

5.16.4.1 No Action Alternative

Under the No Action Alternative, approximately 47.3 million acres of BLM-administered lands would be available for applications for solar energy development. Of the total lands available for application, 330,195 acres are located within existing priority areas, approximately 15.7 million acres are variance lands allocated in the 2012 Western Solar Plan for the six-state planning area, and approximately 31.6 million acres would be available for application within the five additional states considered in this Programmatic EIS, as these lands were not addressed in the 2012 Western Solar Plan. However, solar energy development is expected to occur only on approximately 700,000 acres (the RFDS value), or 1.4% of BLM-administered lands available for solar ROW application under the No Action Alternative.

Specially designated lands and LWCs within the 11-state planning area have the potential to be impacted (e.g., visual impacts, reduced access, fugitive dust) during both the construction and operations phases. Within the six states covered by the 2012 Western Solar Plan, these would be indirect impacts, as all NCL lands would be excluded in these states, along with ACECs; Desert Wildlife Management Areas; National Recreation Trails and National Back Country Byways; and WSRs and segments of rivers determined to be eligible or suitable for WSR status. Within the five states not addressed in the 2012 Western Solar Plan, utility-scale solar energy development could occur in specially designated areas and LWCs, after application of any exclusions specified in applicable land use plans. In the six states addressed under the 2012 Western Solar Plan, the design features from that plan would mitigate specially designated areas and LWC impacts. In the five new states, required mitigation measures for specially designated areas and LWCs would be established at the project-specific level.

5.16.4.2 Action Alternatives

The types of impacts on specially designated areas and LWCs described in Section 5.16.1 would be similar to those under the No Action Alternative; however, all specially designated areas and LWCs in the 11-state planning area would be excluded from solar application as opposed to only those in the six states addressed in the 2012 Western Solar Plan. Under the Action Alternatives, specially designated lands (NCLs; ACECs; desert wildlife management areas; national recreation trails and national back country byways; WSRs and segments of rivers determined to be eligible or suitable for WSR status; and all areas where there is an applicable land use plan decision to protect LWCs) are excluded across the entire 11-state planning area instead of only within the six states in the 2012 Western Solar Plan.

Alternative 1. Approximately 55 million acres of BLM-administered lands would be available for utility-scale solar application. The RFDS assumes that solar energy development would be limited to approximately 700,000 acres, which is about 1% of the BLM-administered lands available for solar ROW application under Alternative 1. Alternative 1 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria, while making all other lands available for application. Alternative 1 would make more lands available for application than are currently available under the No Action Alternative. The magnitude of impacts on specially designated areas and LWC would depend on the location of solar energy development in proximity to these areas. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 2. Approximately 36.2 million acres of BLM-administered lands would be available for utility-scale solar application. The RFDS assumes that solar energy development would be limited to approximately 700,000 acres, which is about 2% of the BLM-administered lands available for solar ROW application under Alternative 2. Alternative 2 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a >10% slope exclusion. The magnitude of impacts on specially designated areas and LWC would depend on the location of solar energy development in proximity to these areas. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 3. Approximately 22.2 million acres of BLM-administered lands would be available for utility-scale solar application. The RFDS assumes that solar energy development would be limited to approximately 700,000 acres, which is about 3% of the BLM-administered lands available for solar ROW application under Alternative 3. Alternative 3 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and 10% slope exclusion. Alternative 3 would also limit development to areas that are less than 10 miles from existing and planned transmission lines of >100 kV, decreasing the amount of land available for solar energy development. Specially designated areas are excluded from solar energy development, but such areas near solar energy facilities could still be adversely impacted. Impacts would depend on the characteristics of the solar energy facility and the proximity to the specially designated area. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 4. Approximately 11.2 million acres of BLM-administered lands would be available for utility-scale solar application. The RFDS assumes that solar energy development would be limited to approximately 700,000 acres, which is about 6% of the BLM-administered lands available for solar ROW application under Alternative 4. Alternative 4 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and 10% slope exclusions, and limiting development to previously disturbed lands, limiting the area in which new land disturbance could occur. Specially designated areas are excluded from solar energy development, but such areas near solar energy facilities could still be adversely impacted. Impacts would depend on the characteristics of the solar energy facility and the proximity to the specially designated area. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 5. Approximately 8.4 million acres of BLM-administered lands would be available for utility-scale solar application. The RFDS assumes that solar energy development would be limited to approximately 700,000 acres, which is about 8% of the BLM-administered lands available for solar ROW application under Alternative 5. Alternative 5 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and 10% slope exclusion. Alternative 5 would also combine the requirement that development be limited to areas that are less than 10 miles from existing or planned transmission lines (from Alternative 3) with the requirement to limit development to previously disturbed lands (from Alternative 4), making it the alternative with the least lands available for solar ROW application. Alternative 5 provides a focus on areas that may be more likely to be economically feasible for development because the lands are near the transmission grid and limit the amount of new land disturbance. Specially designated areas are excluded from solar energy development, but such areas near solar energy facilities could still be adversely impacted. Impacts would depend on the characteristics of the solar energy facility and the proximity to the specially designated area. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

5.17 Transportation

5.17.1 Direct and Indirect Impacts

This analysis is limited to non-recreation transportation routes that would be used for the transportation of materials, equipment, and as commuter routes during construction, operations, and decommissioning of a solar energy facility. An analysis of project impacts on recreation access routes (e.g., OHV use) is provided in Section 5.14, Recreation. Primary impacts on transportation are expected for the road network. Workers are expected to commute to work over local roads, and shipments to and from the solar energy facilities are expected to be by truck, although rail transport to the closest intermodal facility for materials could be used. Impacts on transportation and traffic would occur if the project would increase traffic relative to existing conditions resulting in a change in the capacity of the transportation system or disrupt vehicular access on area roads (BLM 2020c). The most likely projected transportation-related impact is the potential degradation of the level of service of local roads around a solar energy facility as a result of increased traffic volumes.

The magnitude of impacts on transportation will depend on the size of the solar energy facility as well as its design parameters and location. Impacts would be larger for a large solar energy facility located in an area far from major highways or where construction water is brought in from offsite because the project would require a large number of trips on local roads and may cause a more substantial change in traffic patterns. Impacts would be expected to be smaller for smaller utility-scale solar energy facilities, located near major highways or where water is obtained onsite because the project would require fewer trips and would not cause a large change in traffic patterns.

5.17.1.1 Construction

The majority of transportation operations would involve movement of workers, material, and equipment to the site during construction. The types and amounts of material and equipment required for construction of PV solar energy projects would depend on site characteristics and facility size.

Shipments of overweight and/or oversized loads can be expected to cause temporary disruptions on the roads used to access the construction site. It is possible that local roads might require fortification of bridges and removal of obstructions to accommodate overweight or oversized shipments. The need for such actions would be determined on a site-specific basis. Moreover, an access road for solar energy facility would be constructed to accommodate such shipments. Travel during off-peak hours and/or temporary road closures may be necessary for overweight or oversized loads. Most of the construction equipment (e.g., heavy earthmoving equipment and cranes) would remain at the site for the duration of construction activities. Because such construction equipment is routinely moved on U.S. roads and there will be only a limited number of one-time shipments, no significant impact is expected from these movements to and from the construction site.

The movement of other equipment and materials to the site during construction would cause a small increase in the level of service of local roadways during the construction period. Shipments of materials, such as gravel, concrete, water, and solar components, would not be expected to significantly affect local primary and secondary road networks. Deliveries are more likely to occur during morning work hours but could occur anytime during the day. Increased traffic due to equipment and material deliveries is not expected to change the level of service for any road classification used to ship equipment and materials.

Impacts could arise from workers commuting to the construction site for larger projects. The peak daily construction workforce could average several hundred over a construction period ranging up to 2 to 4 years. In the worst case, workers driving individually to the project site could degrade the level of service, especially for local roads (BLM 2018c), possibly resulting in intermittent traffic delays. If water needs to be transported to a project site, the number of trucks accessing the project site could surpass over 100 additional trips per day (BLM 2019c). Also, limited access can lead to more significant impacts should delays occur due to inclement weather, road maintenance or construction, higher vehicle volumes, or traffic accidents (BLM 2019c).

While the number of workers required during different phases of construction would vary, increased commuter traffic in the vicinity of the project may require road improvements or other measures to alleviate congestion or traffic hazards. Depending on the relative locations of the worker population and the site, the use of carpools and shuttle buses may be options for reducing the number of vehicles entering or departing the site during the morning and evening rush hours (BLM 2019c). Road extensions, widening, and other improvements would increase the size and improve the quality of the local roadway network (BLM 2015b).

The types of heavy equipment required would include bulldozers, graders, excavators, front-end loaders, compactors, and dump trucks. Typically, the equipment would be moved to the site by flatbed combination truck and would remain on site through the duration of construction activities. Typical construction materials hauled to the site would include gravel, sand, and water, which are generally available locally. Ready-mix concrete might also be transported to the site, if needed. Peak truck deliveries of materials and supplies, including solar array components, might be expected to be on the order of 50 trucks per day. In addition, it is likely that a small number of one-time oversized and/or overweight shipments may be required for the larger earthmoving equipment required for site preparation. In cases of previously disturbed areas, demolition of existing structures might be necessary prior to grading and project construction. Any resulting debris would be required to be shipped offsite to an appropriate disposal facility.

Utility-scale solar energy projects are expected to have an insignificant impact on railroad operations. However, potential conflicts could arise if there are rail crossings near roads heavily involved with site traffic, especially during the construction period. An increased risk of a collision between a train and a vehicle could occur, most notably from drivers trying to beat a train because of frustration with site-related traffic congestion (BLM 2019c).

5.17.1.2 Operations and Maintenance

Transportation activities during operations would involve commuting workers, material shipments to and from the facility, and onsite work and travel. The number of daily on-site workers will be greatly reduced compared to construction resulting in far less commuter traffic. Operation of PV solar energy facilities would require a small number of onsite personnel, but the precise number would depend on the capacity of the facility. For example, smaller PV facilities could be monitored remotely with no staff present on a daily basis. Larger facilities could require up to about 20 individuals present on a daily basis (BLM 2020c)

Generally, a few daily truck shipments to or from a site would be expected. With facility sizes up to 6,000 acres (24.3 km^2), onsite operations would include travel to various locations for repairs and maintenance, including dust suppression and cleaning operations. If onsite water is not available for these latter operations, shipments of water to the facility location would be required. Deliveries of materials during operations could include hazardous materials such as fuels for backup generators or maintenance vehicles. Shipments of hazardous materials require proper route selection as well as appropriate operator training and qualifications. However, all types of hazardous materials transported for use at solar energy facilities are routinely shipped in the United States for other applications and pose no unusual hazards. Thus, no significant impacts are expected from hazardous material shipments (see Section 5.7). Shipments from facilities would include waste for disposal. The location of large solar energy facilities can have direct impacts on the local road network, posing an impediment to travel from offsite locations on one side to destinations on another. Additional travel times and added traffic congestion could result.

Consequently, transportation activities during operations would be limited to a small number of daily trips by personal vehicles and a few truck shipments at most. It is possible that large components may be required for equipment replacement in the event of a major equipment malfunction. However, such shipments would be expected to be infrequent. The level of transportation activity during operations is expected to have an insignificant impact on the local transportation network.

Once operational, while most solar PV panels are designed to minimize glare, some localized glare could occur. Solar PV modules would be ground mounted and tilted upward. At this distance, glare would generally be minor; however, if the panels were glass covered, they could result in glare that would impact motorist safety (BLM 2018c). Design features would reduce this impact.

5.17.1.3 Transmission Lines and Roads

The location of the site with respect to the electric grid will determine where the electric transmission line from the site will connect to the grid and the route and length of the transmission line. Likewise, gas and water utility lines could be required. The construction and operation of the transmission, water, and gas lines would not be expected to result in any significant transportation impacts, but the addition of any construction workers associated with them could increase impacts coupled with the construction workers associated with the solar energy facility itself, as discussed previously.

On BLM-managed lands, new road construction and roads improved for project use would be required to meet or exceed the minimum standards of width, alignment, grade, surface, and other requirements presented in BLM Manual 9113 (BLM 2015d).

Roads, railroads, transmission lines, and other uses of utility corridors often follow common parallel alignments and often cross one another. The use of a common corridor and railroad crossings in general present potential safety issues and risks routinely addressed throughout the country (BLM 2015b).

Heavy equipment that would be used to construct a new transmission line include cranes, cement mixers, and drilling equipment. Transmission line construction workers and delivery vehicles would be dispersed along the transmission line route (BLM 2018c). All ground disturbances would likely be confined to the ROW.

Construction of new access roads would be required only as necessary to access structure sites lacking direct access from existing roads or where topographic conditions (e.g., steep terrain, rocky outcrops, and drainages) prohibit safe overland access to the site on unpaved roads. Where terrain and soil conditions are suitable, non-graded overland access ("drive & crush") would be used. New access roads would be located within the transmission line ROW wherever practical and would be sited to minimize potential environmental impacts (BLM 2015b).

Road construction and installation of transmission lines would add vehicle travel to the roadway network and could introduce travel obstructions on local roads creating potential safety issues. No hazardous or unsafe conditions would be expected for motorists and pedestrians given compliance with design features, applicable design and operational standards, regulations, laws and permit requirements (BLM 2015b).

Minor delays may occur during installation of transmission lines over major roadways. Incidental travel time delays are not expected to influence emergency response times substantially and would not substantially inconvenience travelers using the roadway network (BLM 2015b).

5.17.1.4 Decommissioning

With some exceptions, transportation activities during site decommissioning would be similar to those during site construction. Heavy equipment and cranes would be required for dismantling solar arrays, breaking up array foundations, and re-grading and re-contouring the site to the original grade. Aside from any construction equipment, oversized and/or overweight shipments are not expected during decommissioning activities, because any major components can be disassembled, segmented, or reduced in size prior to shipment. The access road, onsite roads, rock or gravel in the electrical substations, transformer pads, and building foundations would be removed and recycled if no longer needed. Concrete slab foundations would be broken up. Broken concrete could be used by highway departments for road base or bank stabilization.

Although the number of workers and trucks required during decommissioning is not known, it is likely to be similar to the construction activities. Therefore, the increased traffic during decommissioning would have the same contribution to traffic conditions as during peak construction. However, traffic conditions are likely to change over the life of a project, the road conditions at the time of decommissioning are unknown and estimating these conditions would be speculative.

5.17.2 Cumulative Impacts

A wide variety of activities and development contribute to the current cumulative conditions for transportation, traffic, and public access in the planning area, including recreational activities; mining; solar and other renewable energy development; electric utilities, natural gas, petroleum products and communications; and ranching and farming. These types of past and ongoing projects and activities would combine with traffic generated by solar energy development to affect transportation and public access.

Past and present activities have had a generally beneficial impact on transportation. Construction of linear projects such as roads, railroads and transmission lines has occurred throughout the planning area, with negligible impact on primary roadway traffic. Once constructed, new roads have had a beneficial impact on primary roadway traffic by improving the transportation network and conforming to long-term transportation plans. The construction of roads on or near BLM-administered lands has increased public accessibility to BLM roads and roadless areas. Any project that is within the vicinity of an airport would be expected to consult with the airport to ensure conformity with airport operations and plans. Therefore, there would not be a cumulative impact on traffic on primary roadways, future transportation plans, and airports.

Impacts on transportation systems from solar energy development would occur mainly during construction of facilities and would affect primarily local road systems and traffic flow. Such impacts would be temporary and could be mitigated through design features such as making minor road improvements at access points and reducing traffic congestion through carpooling and coordination of shift changes. Other projects could feasibly be constructed simultaneously, but not all projects would contribute vehicle trips to the same roadways as used for solar projects. Cumulative daily trips distributed along roadways would be dependent upon the location of the cumulative projects. As long as roads operate within acceptable levels-of-service, cumulative impacts would not be substantial. Additional developments in the area (on both BLM-administered as well as other federal, private, or state lands) could contribute to transportation-related cumulative impacts if the developments impact local road systems and traffic flow.

Because of the small number of workers required to operate PV solar energy facilities and the relatively low level of maintenance and delivery traffic to and from facilities required for operation, cumulative impacts on transportation systems during facility operations would be minimal. Cumulative impacts during decommissioning would be similar to those during construction.

5.17.3 Design Features

The BLM has identified design features that will be requirements for all utility-scale solar energy projects on BLM-administered lands subject to the ROD for this Programmatic EIS. The list of design features that have been identified to avoid, minimize, and/or compensate for potential impacts on transportation from solar energy development can be found in Appendix B.17.

5.17.4 Comparison of Alternatives

5.17.4.1 No Action Alternative

Under the No Action Alternative, approximately 47.3 million acres of BLM-administered lands would be available for applications for solar energy development. Of the total lands available for application, 330,195 acres are located within existing priority areas, approximately 15.7 million acres are variance lands allocated in the 2012 Western Solar Plan for the six-state planning area, and approximately 31.6 million acres would be available for application within the five additional states considered in this Programmatic EIS, as these lands were not addressed in the 2012 Western Solar Plan. However, solar energy development is expected to occur only on approximately 700,000 acres (the RFDS value), or 1.4% of BLM-administered lands available for solar ROW application under the No Action Alternative. Transportation impacts described in Section 5.17.1 could occur from the construction and operation of PV solar energy facilities under the No Action Alternative. In the six states addressed under the 2012 Western Solar Plan, the design features from that plan would mitigate transportation impacts. In the five new states, required mitigation measures for transportation impacts would be established at the project-specific level.

5.17.4.2 Action Alternatives

Alternative 1. Approximately 55 million acres of lands would be available for solar energy development on BLM-administered lands. The RFDS estimates that solar energy development would occur only on approximately 700,000 acres, which is about 1% of the land available for solar ROW application under Alternative 1. Alternative 1 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria, while making all other lands available for application. Alternative 1 would make more lands available for application than are currently available under the No Action Alternative. Nevertheless, the magnitude of impacts on transportation is expected to be low and similar across alternatives. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 2. Approximately 36.2 million acres of lands would be available for solar energy development on BLM-administered lands. The RFDS estimates that solar energy development would occur only on approximately 700,000 acres, which is about 2% of the lands available for solar ROW application under Alternative 2. Alternative 2 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a >10% slope exclusion. The magnitude of impacts on transportation is expected to be low and similar across alternatives. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 3. Approximately 22.2 million acres of lands would be available for solar energy development on BLM-administered lands. The RFDS estimates that solar energy development would occur only on approximately 700,000 acres, which is about 3% of the lands available for solar ROW application under Alternative 3. Alternative 3 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a >10% slope exclusion. Alternative 3 would also limit development to areas that are less than 10 miles from existing or planned transmission lines of >100 kV, focusing development in areas that may be more likely to be economically feasible for development. It is possible that impacts on transportation could be smaller under Alternative 3 than Alternatives 1 and 2. Limiting development to areas within 10 miles of existing or planned transmission lines could concentrate solar energy development to areas near existing roadways and access roads that have been developed for the nearby transmission lines. Nevertheless, the magnitude of impacts on transportation is expected to be low and similar across alternatives. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 4. Approximately 11.2 million acres of lands would be available for solar energy development on BLM-administered lands. The RFDS estimates that solar energy development would occur only on approximately 700,000 acres, which is about 6% of the lands available for solar ROW application under Alternative 4. Alternative 4 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria, a >10% slope exclusion, and limiting development to previously disturbed lands and thereby limiting the area in which new land disturbance could occur. It is possible that impacts on transportation could be smaller under Alternative 4 than Alternatives 1 and 2. Limiting development to previously disturbed lands could concentrate solar energy development to areas near existing roadways and access roads that have been developed for other purposes. Nevertheless, the magnitude of impacts on transportation is expected to be low and similar across alternatives. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 5. Approximately 8.4 million acres of lands would be available for solar energy development on BLM-administered lands. The RFDS estimates that solar energy development would occur only on approximately 700,000 acres, which is about 8% of the lands available for solar ROW application under Alternative 5. Alternative 5 would also combine the requirement that development be limited to areas that are less than 10 miles from existing or planned transmission lines of >100 kV (from Alternative 3) with the requirement to limit development to previously disturbed lands (from Alternative 4), making it the alternative with the least lands available for solar ROW application. Alternative 5 provides a focus on areas that may be more likely to be economically feasible for development because the lands are near the transmission grid and limit the amount of new land disturbance. It is possible that impacts on transportation could be smaller under Alternative 5 than Alternatives 1 and 2. Limiting development to previously disturbed lands and within 10 miles of transmission lines could concentrate solar energy development to areas near existing roadways and access roads that have been developed for the nearby transmission lines or for other purposes. Nevertheless, the magnitude of impacts on transportation is expected to be low and similar across alternatives. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

5.18 Tribal Interests

Utility-scale solar energy development could affect resources of Tribal Interests in and around the areas where they are built. Impacts could occur from land disturbance during construction and from the location of facilities. The following subsections discuss the common impacts from solar energy development that could affect such concerns.

5.18.1 Direct and Indirect Impacts

Tribal Interests include trust assets and resources, TCPs, burial remains, sacred sites or landscapes, ecological balance and environmental protection, water quality and use, human health and safety, economic development and employment, rights to hunting, fishing, and gathering of specific resources for traditional purposes and use, and access to energy resources. As discussed in Section 4.18, these issues and concerns should be viewed and evaluated collectively and concurrently with Tribes using a holistic approach. Impacts on these resources may be discussed in the following sections in this Programmatic EIS and should be evaluated by Tribes through formal consultation: cultural resources (Section 5.3), geological setting and soil resources (Section 5.6), mineral resources (Section 5.11), water resources (Section 5.20), air quality and climate resources (Section 5.2), visual resources (Section 5.19), acoustic environment such as noise impacts (Section 5.1), and ecological resources (Section 5.4) such as vegetation (Section 5.4.1), wildlife (Section 5.4.3), aquatic biota and habitats (Section 5.4.2), and SSS (Section 5.4.4), and rangeland resources (Section 5.13) such as livestock grazing (Section 5.13.1). Consultation on this Programmatic EIS between the BLM and the potentially affected Tribes is ongoing.

The potential for impacts on resources of significance to Tribes from solar energy development (including ancillary facilities such as access roads and transmission lines) in many instances is directly related to the amount of land disturbance and the location of the project. Indirect impacts associated with potential solar energy development as identified by the agency—such as impacts on water quality and use, the ecosystem in general, and the cultural landscape resulting from the erosion of disturbed land surfaces—are also considered direct impacts to affected Tribal communities. Impacts on social services, economic development, employment, EJ, and human health and safety are discussed in other sections of Chapter 5.

Impacts on resources of concern to Tribal communities could result in several ways, as described below.

- Complete destruction of an important location, habitat type, archaeological sites, sacred sites, burial, TCPs, specific habitat for culturally important plants and wildlife species, and the like located in the project ROW could result from the clearing, grading, and excavation of the project area and from construction of facilities and associated infrastructure.
- Degradation and/or destruction of an important location could result from the alteration of topography, alteration of hydrologic patterns, removal of soils, erosion of soils, runoff into and sedimentation of adjacent areas, and oil or other contaminant spills if important sites or habitats are located on or near the project area. Such degradation could occur both within the project ROW and in areas downslope or downstream. While the erosion of soils could negatively affect areas downstream of the project area by potentially eroding materials and portions of sites, the accumulation of sediment could serve to protect some sites by increasing the amount of protective cover.
- Modifications of natural flow systems, including impacts on floodplains, wetlands, and riparian areas and possible degradation of surface water quality could occur as a result of construction activities and water withdrawals for a solar energy development project (see Section 5.20).
- Increases in human access and subsequent disturbance (e.g., looting, vandalism, and trampling) of resources of significance to Tribes could result from the establishment of corridors or facilities in otherwise intact and inaccessible areas. Increased human access (including OHV use) exposes plants, animals, archaeological sites, historic structures and features, and other culturally significant natural features to greater probability of impact from a variety of stressors.
- Visual degradation of settings associated with significant cultural resources and sacred landscapes could result from the presence of a utility-scale solar energy development and associated land disturbances and ancillary facilities. This could affect significant resources for which visual integrity is a component of the sites' significance to the Tribes, such as sacred sites, landscapes, and trails.
- Noise degradation of settings associated with significant cultural resources and sacred landscapes also could result from the presence of a utility-scale solar energy development and associated land disturbances and ancillary facilities. This could affect the pristine nature and peacefulness of a culturally significant location.

5.18.2 Cumulative Impacts

Solar energy development areas lie on or near lands of current and historical interest to numerous Native American Tribes. Solar energy facilities could be of concern to Tribes because of an array of potential impacts. Foremost among these would be impacts on the landscape, which would be dramatically altered by solar energy facilities as described in Section 5.19 (Visual Resources). Other resources of concern include trails, sacred sites, and burial sites as well as traditionally collected plants, game, minerals, wildlife grazing areas, water bodies, aquatic habitats, and other resources described in Section 4.18. Consultation with affected Tribes is required prior to siting and construction of solar energy facilities. Mitigation of impacts on Tribal Interests would involve any and all mitigation otherwise identified for the affected resources (plants, water, air, visual, etc.). Cumulative impacts on Native American concerns from foreseeable development in the 11-state region are currently unknown, because consultation is still ongoing (see Appendix D of this document, and Appendix K of the 2012 Western Solar Plan for concerns that have been raised to date). Under the RFDS, the BLM estimates that a total combined area of approximately 700,000 acres of BLM-administered lands and 600,000 acres of other lands (including private lands and state-owned lands) across the 11-state planning area will host utility-scale PV solar energy development over the next 20 years; therefore, solar energy development could make a significant contribution to cumulative impacts, as would wind and geothermal development. Other future development that would affect the visual landscape, ecological communities, water resources, or cultural resources would also contribute to cumulative impacts.

5.18.3 Design Features

The BLM has identified design features that will be requirements for all utility-scale solar energy projects on BLM-administered lands subject to the ROD for this Programmatic EIS. The list of design features that have been identified to avoid, minimize, and/or compensate for potential impacts in areas of Tribal concern from solar energy development can be found in Appendix B.18.

5.18.4 Comparison of Alternatives

5.18.4.1 No Action Alternative

Under the No Action Alternative, approximately 47.3 million acres of BLM-administered lands would be available for applications for solar energy development. Of the total lands available for application, 330,195 acres are located within existing priority areas, approximately 15.7 million acres are variance lands allocated in the 2012 Western Solar Plan for the six-state planning area, and approximately 31.6 million acres would be available for application within the five additional states considered in this Programmatic EIS, as these lands were not addressed in the 2012 Western Solar Plan. However, solar energy development is expected to occur only on approximately 700,000 acres (the RFDS value), or 1.4% of BLM-administered lands available for solar ROW application under the No Action Alternative. Impacts on resources of significance to

Tribes described in Section 5.18.1 could occur from the construction and operation of PV solar energy facilities under the No Action Alternative. In the six states addressed under the 2012 Western Solar Plan, the design features from that plan would mitigate impacts on resources of significance to Tribes. In the five new states, required mitigation measures for impacts on resources of significance to Tribes would be established at the project-specific level.

5.18.4.2 Action Alternatives

Alternative 1. Approximately 55 million acres of BLM-administered lands would be available for utility-scale solar ROW application.

Alternative 2. Approximately 36.2 million acres of BLM-administered lands would be available for utility-scale solar application.

Alternative 3. Approximately 22.2 million acres of BLM-administered lands would be available for utility-scale solar application.

Alternative 4. Approximately 11.2 million acres of BLM-administered lands would be available for utility-scale solar application.

Alternative 5. Approximately 8.4 million acres of BLM-administered lands would be available for utility-scale solar application.

The RFDS estimates that solar energy development would occur only on approximately 700,000 acres within BLM-administered lands available under Alternatives 1 through 5. Impacts on resources of significance to Tribes described in Section 5.18.1 could occur from the construction and operation of PV solar energy facilities under the Action Alternatives. The magnitude of impacts would depend on the location of solar energy development and proximity to areas of concern to Tribes. It is possible that limiting development to areas within 10 miles of existing or planned transmission lines and previously disturbed areas could avoid new development in areas that may have greater Tribal significance and/or resources. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

5.19 Visual Resources

The construction and operation of utility-scale solar energy facilities may create visual contrasts with the surrounding landscape, primarily because they introduce large, complex, and visually distinctive human-made structures into existing landscapes. Visual impacts may include changes to visual values (e.g., scenic quality) and changes to the existing landscape character both as a result of the visual contrasts created by the facilities and public perception of those changes.

The BLM's Visual Resource Management (VRM) program provides a means of describing visual impacts that may result from proposed projects or activities on BLM-administered lands so that defensible decisions about the disposition can be made and public concern about maintaining scenic values of BLM-administered lands relative to competing resource demands can be included in the decision-making process (BLM 1984). A summary of the BLM's VRM system is provided in Appendix F.19.3.

With respect to visual characteristics, utility-scale solar energy facilities vary in their individual project layouts and locational circumstances. Utility-scale solar energy facilities typically present very large arrays of repeating visual elements with rectilinear geometry and a high degree of visual symmetry. Compared with many other industrial developments (e.g., fossil fuel plants, mines, or manufacturing facilities), solar energy facilities generally exhibit strong visual unity and simplicity, attributes generally associated with positive visual quality, even though they may introduce strong visual contrasts into natural-appearing landscapes. In some cases, some viewers might find particular utility-scale solar energy facilities to be attractive or interesting to view because of the facilities' strong visual unity and simplicity or other factors, such as striking and novel light effects from reflections from solar panels and other reflective surfaces; however, peer-reviewed research studies on this topic are currently not available. Other elements of a solar energy facility (such as roads, substations, and transmission lines) generally do not have the strong visual symmetry of solar PV arrays, and their presence could detract from the project's simplicity, symmetry, and visual unity, potentially increasing negative perceptions of the facility. Thus, while some persons may find the presence of a given solar energy facility improves the scenic quality of the landscape view, others may feel that the visual contrasts caused by a solar facility detract from the scenic quality of the landscape view. The visual impact analysis conducted for this Programmatic EIS assumes that the level of visual contrast between a proposed project and the existing landscape is the measure of the project's visual impact and it does not assess or determine the project's visual quality.

Site- and project-specific analysis is needed to thoroughly assess the potential impacts from a particular project or activity to visual resources. Without precise project or activity information such as the project location and a complete description, only the general nature of potential impacts on visual resources can be described. The following impact analysis provides a general description of the visual changes likely to occur as a result of site characterization, construction, operation, and decommissioning/ reclamation of utility-scale PV solar energy projects (and associated facilities).

Utility-scale PV solar energy facilities typically involve substantial amounts of surface disturbance. The construction and operation of large-scale facilities and equipment would introduce major visual changes into non-industrialized landscapes and could create strong visual contrasts in line, form, color, and texture. Where visible to observers within the foreground-middle ground distance, facilities would normally be expected to attract attention and in many cases would be expected to dominate the view. Visual contrasts at greater viewing distances could still be substantial, depending on type and scale of the project, the viewer location, and other visibility factors. Mitigation measures such as painting the structures in tones that blend with the surrounding landscape and using nonreflective surfaces would reduce color contrasts; however, the rectilinear geometry and large scale of the solar PV arrays, , and in some instances the presence of glint and glare from reflective surfaces would preclude repeating the form, color, and texture[12] of the predominant natural landscape features in non-industrialized landscapes. In some cases strong visual contrast would result. This would be especially true when the facilities were viewed from elevated locations, where the large areal extent of the facilities would be more apparent.

Because of their size and visual contrast with surrounding natural-appearing landscapes, in some circumstances, PV solar energy facilities might be visible from greater than 20 mi (32 km) distance, though unlikely to be noticed by a casual observer, and not recognizable as a solar energy facility at that distance (Sullivan et al. 2012). At shorter distances, and particularly as seen from elevated viewpoints, PV facilities are easily visible and recognizable, as shown in Figure 5.19-1.

Figure 5.19-1. PV Facility in Nevada (center), as Seen from an Elevated Viewpoint at a Distance of 5 mi (8 km) (Credit: Argonne National Laboratory)

5.19.1 Direct and Indirect Impacts

5.19.1.1 Site Characterization

Potential visual impacts that could result from site characterization activities include contrasts in form, line, color, and texture resulting from vegetation clearing, if required for site characterization activities such as meteorological tower construction; the presence of trucks and other vehicles and equipment with associated occasional, short-duration road traffic and parking, and associated dust; the presence of workers; and the presence of idle or dismantled equipment and litter, if allowed to remain on the site. Ruts, windblown dust, and visible vegetation damage may occur from cross-country vehicle traffic if existing or new roads are not used for site characterization activities. If

[12] See BLM (2013f) for discussion of use of form, line, color, and texture in visual impact mitigation.

road upgrading or new road construction is required for site characterization activities, visual contrasts may be introduced, depending on the routes relative to surface contours and the widths, lengths, and surface treatments of the roads. Improper road maintenance could lead to the growth of invasive species or erosion, both of which could introduce undesirable contrasts in line, color, and texture, primarily for foreground and near-middle ground views. Most site characterization visual impacts are generally temporary; however, impacts due to road construction, erosion, or other landform altering or vegetation clearing in arid environments may be visible for several years or more.

5.19.1.2 Construction

Potential visual impacts that could result from construction activities include contrasts in form, line, color, and texture resulting from vegetation clearing for areas such as building pads (with associated debris); road building/upgrading; construction and use of staging and laydown areas; solar panel array and support facility construction; vehicle, equipment, and worker presence and activity; and associated vegetation and ground disturbances, dust, and emissions. Construction visual impacts would vary in frequency and duration throughout the course of construction, which for a utility-scale project may last several years.

Vegetation Clearing

Construction for a solar energy facility requires at least some clearing of vegetation, large rocks, and other objects. The nature and extent of clearing are affected by the requirements of the project, the types of vegetation, and other objects to be cleared. Vegetation clearing and topographic grading would be required for the construction of access roads, maintenance roads, and roads to support facilities (e.g., electric substations), and depending on project-specific site and design characteristics, full or partial clearing of vegetation under the solar panel array may occur. The removal of vegetation would result in contrasts in color and texture, because the varied colors and textures of vegetation would be replaced by the more uniform color and texture of bare soil, and could also introduce contrasts in form and line, depending on the type of vegetation cleared and nature of the cleared surface. Typically, vegetation-clearing activities would create additional visual impacts if refuse materials are not disposed of offsite, mulched, or otherwise concealed.

Road Building and/or Upgrading

As noted previously, construction of new temporary and permanent access roads and/or upgrading of existing roads to support project construction and maintenance activities may be required. Road development may introduce strong linear and color contrasts to the landscape, depending on the routes relative to surface contours and the widths, lengths, and surface treatments of the roads. Construction of access roads would have some associated residual impacts (e.g., vegetation disturbance) that could be evident for some years afterward, with a gradual diminishing of impacts over time.

Construction Laydown Areas

Construction of new solar energy facilities would require construction laydown areas for stockpiling and storage of equipment and materials needed during construction. Construction laydown areas might be several hundred acres in size. For solar energy facilities, a construction laydown area would include a staging area with a construction yard that serves as an assembly point for construction crews and includes offices, storage trailers, and fuel tanks. The nature and extent of visual impacts associated with construction laydown areas would depend in part on the size of the laydown area, the nature of required clearing and grading, and the types and amounts of materials stored at the staging areas. The complex geometric forms, lines, and colors of stored materials and equipment would contrast with the generally simple, “organic” existing landscape. Some newly constructed laydown areas could be converted into permanent facilities for facility maintenance, while others would be reclaimed immediately after completion of construction.

Solar Panel Array and Support Facilities

Construction of a solar panel array and support facilities would also be required for utility-scale solar energy facilities as well as construction of electricity transmission to connect the facility to the electrical grid. Support facilities include buildings and power conversion units (PCUs). Construction activities associated with the panel arrays and support facilities may include clearing, grading, soil compacting, and surfacing, in addition to constructing the PCUs, buildings, fences, and the arrays themselves. Visual contrasts associated with solar panel array and support facilities are described in detail in Section 5.19.1.3.2. Visual contrasts associated with the construction and operation of electric transmission lines and upgrades to existing lines are described in detail in Section 5.19.1.5.

Workers, Vehicles, and Equipment

The various construction activities described above require work crews, vehicles, and equipment that would add to visual impacts during construction. Small-vehicle traffic for worker access and large-equipment traffic (e.g., trucks, graders, excavators, and cranes) would be expected for road and building construction, site preparation, and solar panel array installation. Both kinds of traffic would produce visible motion and dust in dry soils. Suspension and visibility of dust would be influenced by vehicle speeds, road surface materials, and weather conditions. Temporary parking for vehicles would be needed at or near work locations. Unplanned and unmonitored parking could likely expand these areas, producing visual contrast by suspended dust and loss of vegetation. Construction activities would proceed in phases, with several crews moving through a given area in succession, giving rise to brief periods of intense construction activity (and associated visual impacts) followed by periods of inactivity. Cranes and other construction equipment would produce emissions while in operation and could thus create visible exhaust plumes.

Other Visual Impacts from Construction

Ground disturbance would result in visual impacts that would produce contrasts of color, form, texture, and line. Any excavating that might be required for building foundations and ancillary structures, trenching to bury pipelines or cables, grading and surfacing roads, clearing and leveling staging areas, and stockpiling soil and spoils (if not removed) would (1) damage or remove vegetation, (2) expose bare soil, and (3) potentially suspend dust. These activities could create strong color contrasts and, to a lesser degree, contrasts in form, line, and texture. Soil stockpiles could be visible for the duration of construction. Soil scars, exposed slope faces, eroded areas, and areas of compacted soil could result from excavation, leveling, and equipment and vehicle movement. Non-native invasive weed species may colonize disturbed and stockpiled soils and compacted areas. These species may be introduced naturally; in seeds, plants, or soils introduced for intermediate restoration; or by vehicles. In some situations, the presence of invasive species may introduce contrasts with naturally occurring vegetation, primarily in color and texture. The presence of workers and construction activities could also result in litter and debris that could create negative visual impacts within and around work sites. Site monitoring and restoration activities could avoid or reduce many of these impacts.

Other construction activities could include bracing and cutting existing fences and constructing new fences to contain livestock; providing temporary walks, passageways, fences, or other structures to prevent interference with traffic, primarily causing linear contrasts; and providing lighting in areas where work might be conducted at night. The use of lighting for construction activities at night could cause impacts to night skies and dark environments. Lighting impacts are discussed in Section 5.19.1.3.

5.19.1.3 Operations and Maintenance

The operation and maintenance of solar energy projects and associated electricity transmission lines, roads, and ROWs would have potentially substantial long-term visual impacts. Site operation impacts would generally occur throughout the life of the facility, with some impacts (e.g., impacts resulting from land forming and vegetation clearing) potentially continuing many years beyond the lifespan of the project.

Solar Field

The dimensions of the solar field (the area devoted to solar panel arrays) for a given project would depend on project-specific characteristics and would be determined at a project-specific level; in general, however, it would be expected to be in the range of 4 to 7 acres/MW (0.02 to 0.03 km^2/MW), or 5 to 8 acres/MW (0.02 to 0.03 km^2/MW), for facilities with storage capability. Visual impacts associated with solar field clearing (if it occurs) include the potential loss of vegetative screening, which would result in the opening of views; potentially significant changes in form, line, color, and texture for viewers close to the solar field; and potentially significant changes in line and color for viewers with distant views of the solar field. In general, the impacts would be greater in more heavily vegetated (scrub) areas, where vegetation-clearing impacts are more conspicuous, particularly in areas of strong color contrasts between vegetation and soil; however, in some situations, uncleared vegetation outside the facility might screen views of the cleared areas, reducing visible contrasts. The presence of snow cover might accentuate color contrasts. In sparsely vegetated areas, visual impacts from vegetation clearing typically would be expected to be less, because there would normally be less vegetation removal and there are generally fewer contrast issues associated with vegetation removal in these areas.

While the opening of views for viewers close to a cleared solar field might be regarded positively by some viewers in some circumstances, the introduction of strong linear and color contrasts in middleground and background views as a result of clearing could potentially have large negative visual impacts, particularly in more heavily vegetated areas where the viewer is elevated, so that large portions of the solar field are visible. In worst-case situations, the contrast could be visible for many miles.

In addition to form, line, color, and texture contrasts resulting from the exposure of bare soil, vegetation removal could result in windblown dust that could create color contrasts and visible movement of dust clouds, obscure views of nearby landscape features, and degrade general visibility of both day and night skies.

In naturally vegetated areas where bare soils become exposed (generally associated with construction activities), reclamation efforts would include reseeding these areas. Good mitigation practice would dictate reseeding with native plants, which would minimize visual contrasts but, depending on circumstances, in the generally arid environments on BLM-administered lands included in this Programmatic EIS, a number of years might pass before color and texture contrasts between reseeded and uncleared areas would no longer be noticeable. If a lack of proper management led to the growth of invasive species in the reseeded areas, noticeable color and texture contrasts might remain indefinitely. The unsuccessful reclamation of cleared areas may also result in soil erosion, ruts, gullies, or blowouts and could cause long-term negative visual impacts.

Other cleared areas would include maintenance roads and facility access roads (e.g., electric substations or pump stations). Some support facilities would be surrounded by cleared areas. Visual contrasts associated with these cleared areas would include the potential loss of vegetative screening, which would result in the opening of views and potentially significant changes in form, line, color, and texture for viewers close to the cleared area. Clearing for roads might be subject to some of the linear contrast concerns discussed in Section 5.19.1.5 for transmission line ROWs. However, contrasts from roads would normally be far less severe than for ROWs; mainline facility maintenance roads would generally be within the cleared ROW and, in most cases, would not add substantially to the impact, while access roads would generally be shorter. In both cases, the cleared area would be relatively narrow, especially compared with typical electricity transmission line ROW clearings.

Solar Panel Arrays and Support Facilities

The largest visual impacts from solar energy facilities would normally be associated with the solar panel arrays and ancillary structures, including PCUs and buildings.

Solar energy facilities considered in this Programmatic EIS contain PV panels in rectangular arrays mounted on either simple fixed mounts that tilt the panels toward the midday sun or more complex sun-tracking systems that might add slightly to the visual impact, depending on the technology employed and its configuration. Because PV panels are generally low to the ground, usually less than 10 ft (3.0 m), most buildings, some tanks, and possibly other project components would protrude above the PV arrays and would be visible from outside the facility, even in relatively flat areas. Dual tracking panels are generally larger and might be somewhat taller (15 ft [4.6 m] or more) and would screen slightly more of the other project components. Figures 5.19-2 and 5.19-3 show tracking PV panel arrays; Figure 5.19-3 includes human figures to facilitate scale comparison. Figures 5.19-4 through 5.19-8 show fixed panel arrays. In general, the low profile of the solar panels would reduce their visibility when viewed from low viewing angles (see Figure 5.19-5), especially from longer distances. When viewed from elevated positions, more of the facility would be visible and the regular geometry of the panel arrays would be more apparent, resulting in substantially larger visual impacts.

Figure 5.19-2. PV Panels in a Dual-Axis Tracking System, Nellis Air Force Base, Nevada (Credit: Argonne National Laboratory)

Figure 5.19-3. PV Panels in a Single-Axis Tracking System, Sacramento Municipal Utility District, Hedge Substation (Credit: Sacramento Municipal Utility District; Source: NREL 2009)

Figure 5.19-4. Forms and Colors of PCUs Contrast with Surrounding Solar Panel Arrays (Credit: Argonne National Laboratory)

Within the solar field, in addition to panel arrays, PCUs would be located at regularly spaced intervals, as shown in Figures 5.19-4 and 5.19-5. The PCUs are relatively small metal structures containing electrical inverters and other electronics. They typically are taller than fixed solar panels, and their forms (and often colors) contrast with the forms of the panels, adding to visual contrast. Visual contrast between the PCUs and the panels and the surrounding landscape can often be greatly reduced through appropriate color selection for the PCUs (Sullivan and Aplanalp 2013).

Figure 5.19-5. Ground-Level View of PV Facility Showing Solar Array, Facility Buildings, PCUs, Perimeter Fencing, and Associated Monopole Transmission Towers and Conductors (Credit: Argonne National Laboratory)

Buildings common to all solar energy projects include a control/administrative building, a warehouse-shop building, a security building or gatehouse, and a fire-water pump building. These structures would normally be constructed of sheet metal, concrete, or cinder blocks and would be expected to range from approximately 20 to 40 ft (6.1 to 12.2 m) in height.

All utility-scale solar energy facilities would also include various tanks for water and other chemicals (e.g., gasoline or diesel fuel, potable water). Solar energy projects normally would be fenced around the outside perimeter and might include additional fencing around certain support facilities. Landscaping plantings might be included around the control building, or possibly for visual screening in certain situations. A general ground-level view of a PV facility is shown in Figure 5.19-5.

These built structures would introduce complex rectilinear geometric forms and lines and artificial-looking textures and colors into the landscape that would likely contrast markedly with natural-appearing landscapes. Most buildings and some tanks would be of sufficient height to protrude above the PV arrays as viewed from outside the facility and would likely contrast with the PV arrays in terms of form, line, and color.

Solar panel surfaces are mostly black and are designed to absorb as much light as possible; however, the panels do reflect light and under certain viewing conditions, their reflective surfaces can give rise to specular reflections (glint and glare) that may be visible as spots of intensely bright light on the reflective surface or as flashes of bright light to moving observers, and other visual impacts that would also vary depending on panel orientation, sun angle, viewing angle, viewer distance, and other visibility factors. These impacts may include large shifts in apparent color of the panels, from black to gray to silvery white or occasionally blue, as shown in Figures 5.19-6 and 5.19-7. For persons driving on nearby roadways, the color shifts may be very rapid as vehicles pass by the facility. In addition to the panels, facilities would include other components that may have reflective surfaces, such as panel support structures, PCUs, fencing, transmission towers and lines, etc., which may also cause glint, glare, and other unusual visual effects. In some situations, these reflections could be visible for long distances, and could constitute a major source of visual impacts from utility-scale solar energy facilities.

Figure 5.19-6. Low Sun Angle near Sunset Causes Black PV Panels to Appear White and Blue (Credit: Argonne National Laboratory)

Figure 5.19-7. Color Shift of PV Panel Array from Black (left) through Gray (center) to Bluish White (right), as Seen from a Passing Vehicle (buildings visible at right are not part of the PV facility) (Credit: Argonne National Laboratory)

The rectilinear and repeating regular visual pattern created by many thousands of identical solar panels and mounting structures in evenly spaced rows (usually in a rectilinear grid) often creates a distinctly non-natural and sometimes striking and unusual view of the facility that contrasts strongly with natural-appearing backgrounds. An example is shown in Figure 5.19-8, and these contrast sources and circumstances where they arise are discussed by Sullivan and Alplanalp (2013).

Operational activities associated with the PV arrays and support facilities include routine maintenance (such as washing of PV panel surfaces), road and building maintenance, and repairs. These activities would be visible offsite in some cases and might also generate visible dust plumes in some circumstances.

Figure 5.19-8. Geometric Pattern of Reflections from Solar Panel Components at a PV Facility (note that PCUs have been painted to reduce contrast with vegetated mountain backdrop) (Credit: Argonne National Laboratory)

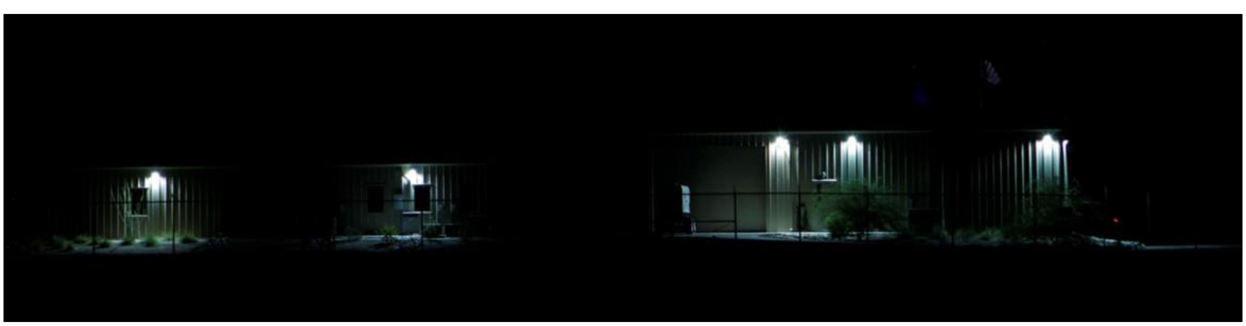

Figure 5.19-9. Poorly Mitigated Lighting on the Administration Building of a PV Facility (Credit: BLM)

Roads

In many cases, construction access roads would not be needed during operations and would be reclaimed after construction. In some cases, certain roads would remain, such as the permanent maintenance roads and the permanent facility access roads. Maintenance roads (where needed) would generally be dirt or gravel, while some facility access roads might be paved. In addition to being cleared of vegetation, roads may introduce strong visual contrasts to the landscape, depending on the routes relative to surface contours and the widths, lengths, and surface treatments of the roads. Improper road maintenance could lead to the growth of invasive species or erosion, both of which could introduce undesirable contrasts in line, color, and texture, primarily for foreground and near-middle ground views.

Lighting

Solar energy facilities would include exterior lighting around buildings (see Figure 5.19-9), parking areas, and other work areas. Security and other lighting around and on support structures (e.g., the control building) could contribute to light pollution. Maintenance activities conducted at night, such as panel washing, might require vehicle-mounted lights, which also could contribute to light pollution. Light pollution impacts associated with utility-scale solar energy facilities include skyglow, light trespass, glare, light clutter, and over-illumination.

Skyglow is a brightening of the night sky caused by both natural and man-made factors. Skyglow decreases a person’s ability to see dark night skies and stars, which is an important recreational activity in many parts of the southwestern United States, including BLM- and non-BLM-administered lands within or near the 11-state planning area. Skyglow effects can be visible for long distances. Outdoor artificial lighting can contribute to skyglow by directing light upwards into the night sky and also through reflection of light from the ground and other illuminated surfaces.

Light trespass is the casting of light into areas where it is unneeded or unwanted, such as when light designed to illuminate an industrial facility falls into nearby residential areas. Poorly placed and -aimed lighting can result in spill light that falls outside the area needing illumination.

Glare is the visual sensation caused by excessive and uncontrolled brightness and, in the context of outdoor lighting, is generally associated with direct views of a strong light source. Poorly placed and aimed lighting can cause glare, as can the use of excessively bright lighting.

Light clutter refers to excessive groupings of lights, such as are seen in typical urban or industrial settings where there are large numbers of lights of different types. Light clutter may be distracting, confusing, and aesthetically impacting, and may contribute to skyglow, light trespass, and glare.

Over-illumination refers to the use of lighting intensity higher than that which is appropriate for a specific activity. An example would be a very brightly lit parking lot where the illumination is far greater than that needed to safely park, locate one's vehicle, and walk. Over-illumination often contributes to the other types of light pollution previously described.

These light pollution impacts from solar energy facilities could be reduced by shielding and/or other mitigation measures (see Appendix B.19); however, any degree of lighting would produce some offsite light pollution, which might be particularly noticeable in dark nighttime sky conditions typical of the rural/natural settings within the 11-state planning area. Sullivan et al. (2023) provide BMPs for mitigating light pollution on BLM-managed lands and, properly implemented, these measures can greatly reduce light pollution from solar energy facilities.

5.19.1.4 Decommissioning/Reclamation

During decommissioning/reclamation, the immediate visual impacts would be similar to those encountered during construction but likely of shorter duration. These impacts likely would include road redevelopment, removal of aboveground structures and equipment, the presence of workers and equipment with associated dust and possibly other emissions and litter, and the presence of idle or dismantled equipment, if allowed to remain onsite. Deconstruction activities would involve heavy equipment, support facilities, and lighting if activities were conducted at night. Decommissioning likely would be an intermittent or phased activity persisting over extended periods of time and would include the presence of workers, vehicles, and temporary fencing at the work site.

Restoring a decommissioned site to pre-project conditions would also entail recontouring, grading, scarifying, seeding, and planting, and perhaps stabilizing disturbed surfaces. This might not be possible in all cases; that is, the contours of restored areas might not always be identical to pre-project conditions. In the arid conditions found in much of the 11-state planning area, newly disturbed soils might create visual contrasts that could persist for many seasons before revegetation would begin to disguise past activity. Invasive species might colonize reclaimed areas, likely producing contrasts of color and texture. If a lack of proper management led to the growth of invasive species in the reseeded areas, noticeable color and texture contrasts might remain indefinitely. The unsuccessful reclamation of cleared areas could also result in soil erosion, ruts, gullies, or blowouts, which could cause long-term negative visual impacts.

5.19.1.5 Transmission Lines

Construction and operation of electric transmission lines and upgrades to existing lines would be required for utility-scale solar energy development. However, the projected linear extent of the transmission facilities and voltage rating (and therefore tower size and substation size) would vary by project. Visual impacts associated with construction, operation, and decommissioning of the electric transmission facilities, and line upgrades would include temporary impacts associated with activities that would occur during the construction and decommissioning phases of the projects, and longer-term impacts that would result from construction and operation of the facilities themselves.

Potential sources of visual contrast resulting in visual impacts from construction activities include ROW clearing with associated debris; road building and upgrading; construction and use of staging areas and laydown areas; mainline and support facility construction; blasting of cavities for tower foundations; vehicular, equipment, and worker presence and activity; and associated vegetation and ground disturbances, dust, and emissions. During decommissioning (only to occur if transmission facilities were not still being used to carry other electrical loads), visual impacts would be similar to those encountered during construction but likely of shorter duration and generally occurring in reverse order from construction impacts.

Construction of an ROW typically requires clearing or selective removal of vegetation, large rocks, and other objects. Vegetation clearing and topographic grading would be required for construction of access roads, maintenance roads, and roads to support facilities (e.g., electric substations). Vegetation-clearing activities could cause visual impacts by creating contrasts in form, line, color, and texture with existing natural landscapes, depending on site-specific factors such as existing vegetation. Road development might introduce strong visual contrasts into the landscape depending on the route relative to surface contours and the width, length, and surface treatment of the roads. Construction access roads would be reclaimed after construction ended, but some associated visual impacts (e.g., vegetation disturbance) might be evident for some years afterward, gradually diminishing over time. Staging areas and laydown areas would be required for stockpiling and storing equipment and materials needed during construction. These areas may require vegetation clearing, may cover 2 to 30 acres (0.01 to 0.12 km^2), and may be placed at intervals of several miles along an ROW.

Transmission line construction activities include clearing, leveling, and excavation at tower sites as well as assembly and erection of towers followed by cable pulling. Potentially these activities would have substantial but temporary visual impacts. Except for substations, because transmission facilities are linear, construction activities would generally proceed as a “rolling assembly line,” with a work crew gradually moving through an area at varying rates depending on circumstances.

The width of cleared area for the permanent ROW for a given project would be determined at a project-specific level. Cleared ROWs might open up landscape views, especially down the length of the ROW, and introduce potentially significant changes in form, line, color, and texture. While in some circumstances viewers might regard the opening of views close to a cleared ROW positively, the introduction of strong linear and color contrasts from clearing of ROWs in mid-ground and background views could create large negative visual impacts, particularly in heavily vegetated or forested areas where either the viewer or the ROW is elevated such that long stretches of ROW are visible. Viewing angle could also be an important factor in determining the perceived visual impact in these settings. In worst-case situations, the impacts could be visible for many miles. Various design and mitigation measures could be used to avoid or reduce impacts in these situations.

Where visible, electric transmission and distribution towers could create potentially large visual impacts. Towers for utility-scale solar energy projects would generally range from 70 to 125 ft (21 to 38 m) in height. Towers would be constructed of metal, wood, or concrete and could be monopole, H-frame, or lattice structures. Transmission towers of both monopole and steel lattice construction are shown in Figure 5.19-10, while an H-frame tower is shown in Figure 5.19-11. The tower structures, conductors, insulators, aeronautical safety markings, and lights (if used) would all create visual impacts. Electric transmission towers would create vertical lines in the landscape, and the conductors would create curving horizontal lines that would be visible depending on viewing distance and lighting conditions. In the open landscapes present in much of the West and under favorable viewing conditions, the towers and conductors might be easily visible for several miles, especially if skylined—that is, placed along ridgelines (Sullivan et al. 2014). A variety of mitigation measures could be used to reduce impacts from these structures, but because of their size, in many circumstances it is difficult to avoid some level of visual impact except at very long distances. A transmission line's visual presence would last from construction throughout the life of the project.

Figure 5.19-10. Lattice (left) and monopole (right) Transmission Towers (Source: Argonne 2007)

Figure 5.19-11. H-Frame Transmission Tower (Source: Sullivan et al. 2014)

Electric transmission projects have associated ancillary structures that would contribute to perceived visual impacts. Electrical substations are located at the start and end points of transmission lines and would be required at locations where line voltage is changed. Substations vary in size and configuration but may be several acres in size; they are cleared of vegetation and typically surfaced with gravel. They are normally fenced, may include security lighting, and are reached by a permanent access road. Substations include a variety of visually complex structures, such as conductors, fencing, lighting, and other features, that result in an “industrial” appearance with generally rectilinear geometry and potentially reflective surfaces. Substation facilities typically introduce strong visual contrasts in line, form, texture, and color where they are located in nonindustrial surroundings, particularly for nearby viewers. The industrial look of a typical substation, together with the substantial height of its structures (up to 40 ft [12 m] or more) and its large areal extent, may result in large negatively perceived visual impacts for nearby viewers.

Electric transmission towers associated with solar energy facilities could require aircraft warning lights in rare circumstances (e.g., in close proximity to airports or crossing rivers). The presence of aircraft warning lights could greatly increase visibility of the transmission structures at night in some locations because the lights could be visible for long distances. In the dark nighttime sky conditions typical of the predominantly rural/natural settings within the 11-state planning area, the warning lights could potentially cause large visual impacts, especially if few similar light sources were present in the area.

5.19.2 Cumulative Impacts

Under the RFDS, the BLM estimates that a total combined area of approximately 700,000 acres of BLM-administered lands and 600,000 acres of other lands (including private lands and state-owned lands) across the 11-state planning area will host utility-scale PV solar energy development over the next 20 years. The introduction of PV solar energy facilities in remote rural areas would alter the landscape and produce dramatic changes in the visual character of many affected areas. In addition, in some portions of the planning area suitable solar energy development locations are in basin flats surrounded by mountains or highlands where sensitive viewing locations exist. Thus, visual impacts could be acute for some observers, including hikers and park visitors, as well as for certain groups, including Native American Tribes or other ethnic groups who live in affected areas.

In addition to visual impacts from solar energy facilities, associated transmission lines, roads, and lighting at night could result in large visual impacts over long distances. Thus, solar energy development would be a major contributor to cumulative visual impacts from foreseeable development in the 11-state region. Overall, cumulative impacts for all development could be significant, including impacts from wind and geothermal development, new roads, transmission lines, pipelines, canals, fences, communication systems, mining, agriculture, commercial development, aviation, and road traffic. Visual impacts from solar energy facilities would be mitigated to the extent practical through the implementation of design features and through careful siting of facilities relative to sensitive viewing sites and sensitive visual resource areas (SVRAs).

5.19.3 Design Features

The BLM has identified design features that will be requirements for all utility-scale solar energy projects on BLM-administered lands subject to the ROD for this Programmatic EIS. The list of design features that have been identified to avoid, minimize, and/or compensate for potential impacts on visual resources from solar energy development can be found in Appendix B.19.

5.19.4 Comparison of Alternatives

Maps showing inventoried scenic quality on BLM-administered lands available for application under the alternatives are presented in Appendix F.19.3.2.

Maps showing night sky artificial brightness on BLM-administered lands available for application under the alternatives are presented in Appendix F.19.3.3.

5.19.4.1 No Action Alternative

Under the No Action Alternative, approximately 47.3 million acres of BLM-administered lands would be available for applications for solar energy development. Of the total lands available for application, 330,195 acres are located within existing priority areas, approximately 15.7 million acres are variance lands allocated in the 2012 Western Solar Plan for the six-state planning area, and approximately 31.6 million acres would be available for application within the five additional states considered in this Programmatic EIS, as these lands were not addressed in the 2012 Western Solar Plan. Under the No Action Alternative 1% of inventoried Scenic Quality Class A acres, 8% of Class B and 10.5% of Class C would be available for application (Table 5.19-1). Visual impacts described in Section 5.19.1 could occur from the construction and decommissioning of PV solar energy facilities under the No Action Alternative. In the six states addressed under the 2012 Western Solar Plan, the design features from that plan would mitigate impacts on visual resources. In the five new states, required mitigation measures for impacts on visual resources would be established at the project-specific level.

As shown in Table 5.19-2 and Figure 5.19-2, of the total lands available for application under the No Action Alternative, approximately 35.1 million acres (73.8%) have an artificial sky brightness (ASB) to natural background sky brightness (NBSB) ratio of 0.00-0.01, which equates to extremely dark skies/environments that are considered pristine with respect to light pollution (Cinzano et al., 2001). The remaining acreage (12.5 million acres, or 26.2%) are distributed through increasingly brighter skies (skies with higher ASB/NBSB ratios), but strongly skewed toward pristine night skies, as shown in Figure 5.19-13. Thus any light pollution from solar energy development would generally occur in areas of pristine or near-pristine night skies, although the actual effects for a given project would depend on its exact location and the effectiveness of mitigation. Compared to the action alternatives, the No Action Alternative would involve approximately 5 million fewer acres of lands with pristine night skies available for application compared with Alternative 1 (See Figure 5.19-1) but with a similar distribution among the ASB/NBSB ratios (See Figure 5.19-2). Action Alternatives 2-5 would make between 8.5 million to 31.4 million fewer acres of pristine night skies available for application, with the No Action Alternative having a very similar distribution of ASB/NBSB ratios to Alternatives 1 and 2, but a greater skew toward pristine or near pristine night skies than Alternatives 3-5.

Table 5.19-1. Scenic Quality Across Alternatives

Alternative	Acres of BLM-Administered Land (excluding DRECP/CDCA)	Scenic Quality Class A		Scenic Quality Class B		Scenic Quality Class C		Missing, Not Inventoried, or No Data for Scenic Quality	
		Acres	Percentage	Acres	Percentage	Acres	Percentage	Acres	Percentage
No Action[a]	162,177,567	1,936,137	1.2%	12,980,101	8.0%	17,357,339	10.7%	15,350,374	9.5%
Alternative 1	162,177,567	3,352,369	2.1%	20,168,294	12.4%	22,438,204	13.8%	8,927,302	5.5%
Alternative 2	162,177,567	1,226,772	0.8%	9,809,786	6.0%	18,029,950	11.1%	5,541,844	3.4%
Alternative 3	162,177,567	853,208	0.5%	6,161,905	3.8%	10,764,919	6.6%	3,425,977	2.1%
Alternative 4	162,177,567	761,547	0.5%	2,350,526	1.4%	4,970,526	3.1%	2,603,286	1.6%
Alternative 5	162,177,567	615,390	0.4%	1,692,585	1.0%	3,696,108	2.3%	1,958,154	1.2%

[a] Priority areas and lands available for application (variance lands in six-state area) combined. These total priority areas in each state have been updated to reflect changes implemented since 2012 (see Section 1.3).

Table 5.19-2. Artificial Sky Brightness Across Alternatives

Artificial Sky Brightness Ratio to Natural Brightness	No Action		Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternative 5	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
0.00 - 0.01	35,149,495	73.807%	39,742,436	72.409%	25,753,618	74.415%	13,693,047	64.572%	5,826,167	54.522%	3,723,012	46.759%
0.01 - 0.02	5,369,697	11.275%	5,981,731	10.898%	3,513,590	10.153%	2,794,381	13.177%	1,567,382	14.668%	1,316,860	16.539%
0.02 - 0.04	3,489,511	7.327%	4,251,258	7.746%	2,235,830	6.460%	1,986,247	9.367%	1,286,305	12.038%	1,138,978	14.305%
0.04 - 0.08	1,932,456	4.058%	2,360,790	4.301%	1,307,266	3.777%	1,187,363	5.599%	804,466	7.528%	742,046	9.320%
0.08 - 0.16	1,017,594	2.137%	1,359,954	2.478%	902,992	2.609%	828,342	3.906%	538,266	5.037%	498,130	6.256%
0.16 - 0.32	419,996	0.882%	801,537	1.460%	590,614	1.707%	450,507	2.124%	420,585	3.936%	330,574	4.152%
0.32 - 0.64	145,080	0.305%	295,952	0.539%	224,928	0.650%	194,798	0.919%	177,375	1.660%	154,883	1.945%
0.64 - 1.28	59,737	0.125%	79,311	0.145%	68,182	0.197%	60,893	0.287%	55,685	0.521%	49,002	0.615%
1.28 - 2.56	27,521	0.058%	10,499	0.019%	8,809	0.026%	7,911	0.037%	7,154	0.067%	6,256	0.079%
2.56 - 5.12	10,381	0.022%	2,365	0.004%	2,240	0.007%	2,240	0.011%	2,240	0.021%	2,240	0.028%
5.12 - 10.2	2,300	0.005%	241	0.000%	207	0.001%	207	0.001%	207	0.002%	207	0.003%
10.2 - 20.5	87	0.000%	0	0.000%	0	0.000%	0	0.000%	0	0.000%	0	0.000%

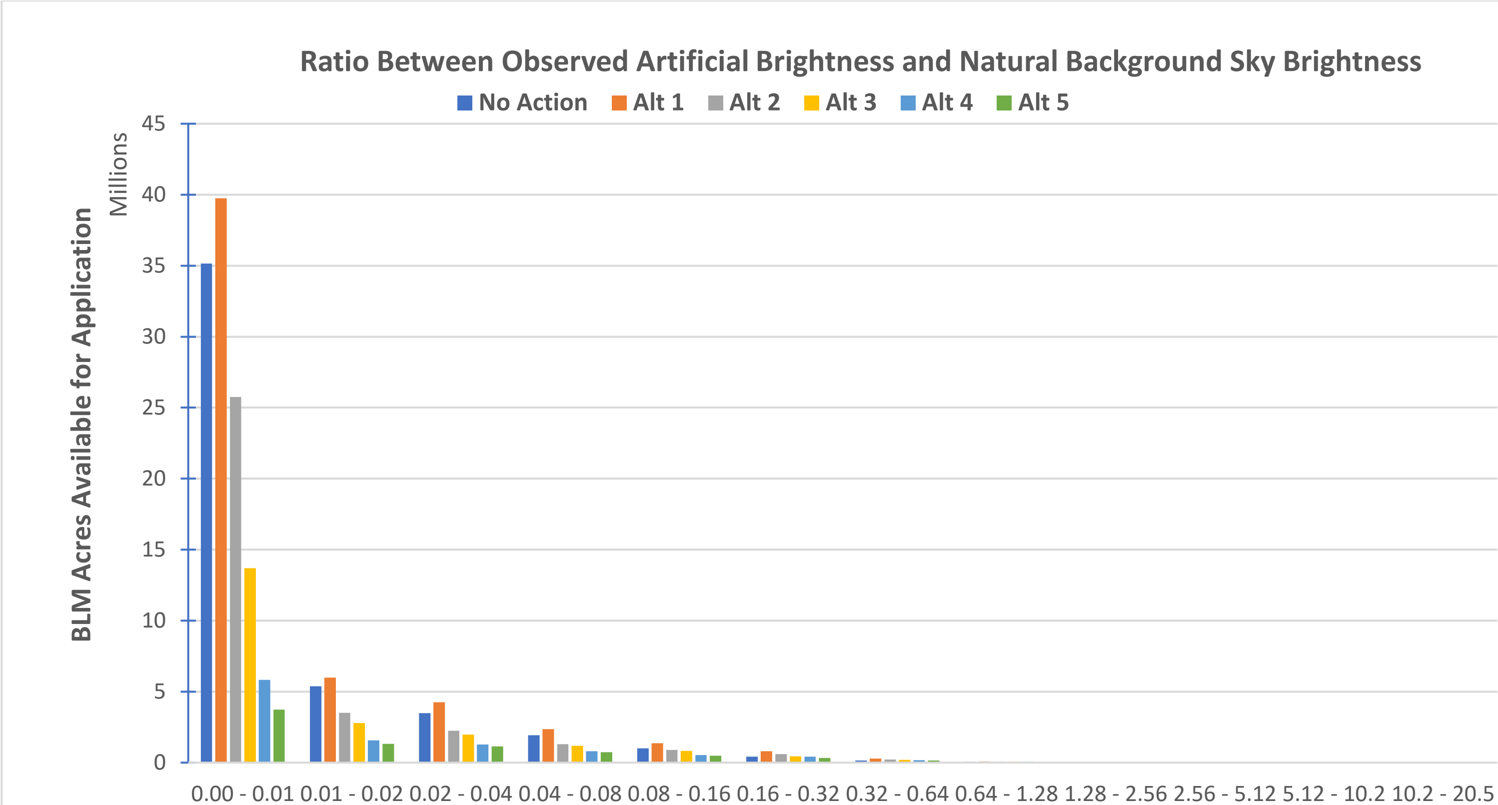

Figure 5.19-12. BLM Acreage Available and Artificial Sky Brightness Ratio to Natural Sky Brightness across Alternatives (Source: Argonne 2023)

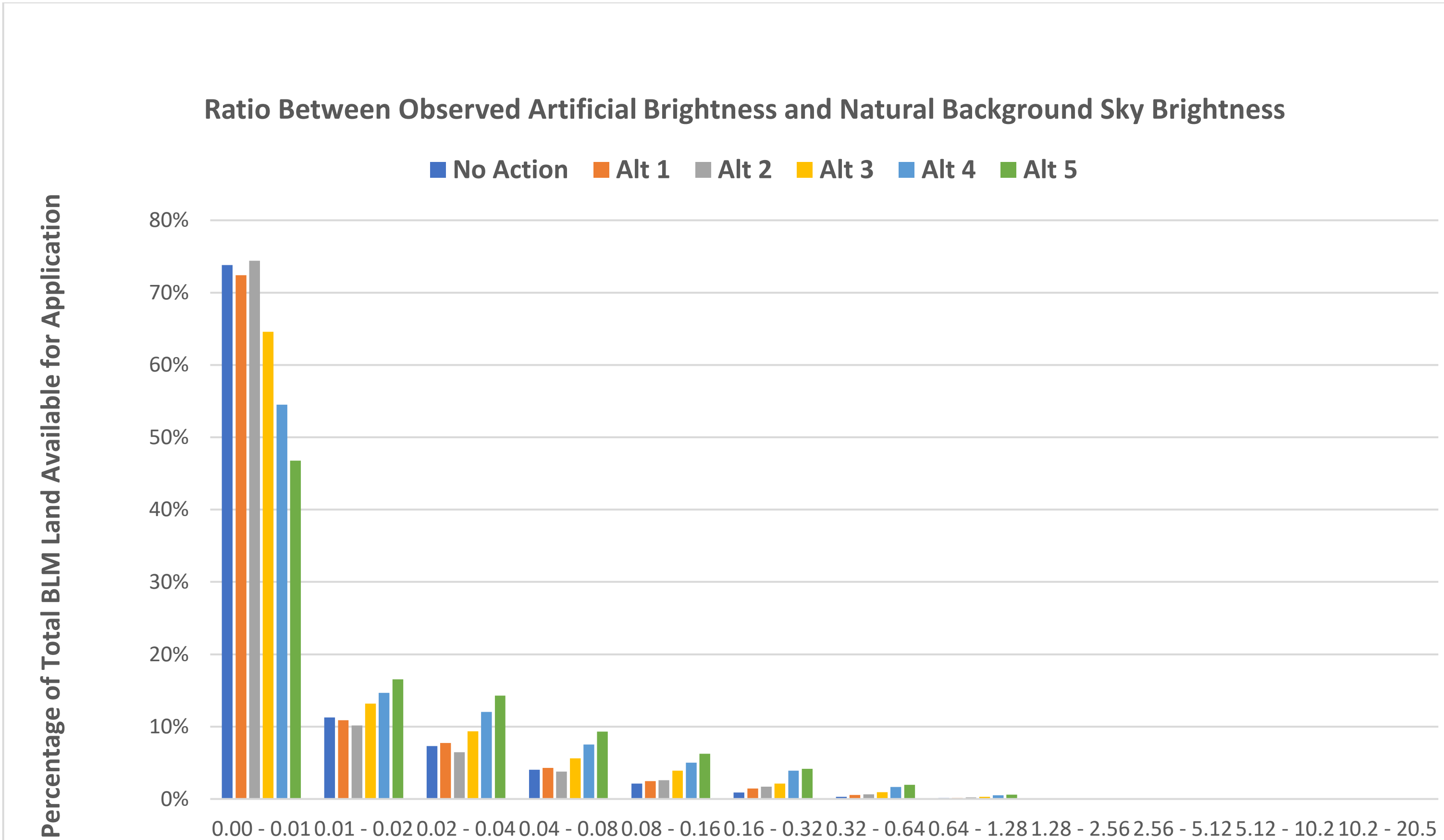

Figure 5.19-13. Percentage of Total BLM Acreage Available and Artificial Sky Brightness Ratio to Natural Sky Brightness across Alternatives (Source: Argonne 2023)

5.19.4.2 Action Alternatives

Alternative 1. Approximately 55 million acres of BLM-administered lands would be available for utility-scale solar application. While 2% of the acres available are inventoried Scenic Quality Class A, 12% are Class B and 14% are Class C (Table 5.19-1), the RFDS assumes that solar energy development would be limited to approximately 700,000 acres which is about 1% of the lands available under Alternative 1. Alternative 1 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria, while making all other lands available for application. Alternative 1 would make more lands available for application than are currently available under the No Action Alternative. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Of the total lands available for application under Alternative 1, approximately 39.7 million acres (72.4%) have pristine night skies. The remaining acreage (15.1 million acres, or 27.6%) are distributed through increasingly brighter skies, but strongly skewed toward pristine skies. Compared to the No Action Alternative and the other Action Alternatives, Alternative 1 would make the greatest amount of lands with pristine night skies available for application, with a similar distribution among the ASB/NBSB ratios as the No Action Alternative and Alternative 2, but a greater skew toward pristine or near pristine night skies than Alternatives 3-5.

Alternative 2. Approximately 36.2 million acres of BLM-administered lands would be available for utility-scale solar application. While 1% of the acres available are Scenic Quality Class A, 6% are Class B and 11% are Class C (Table 5.19-1), the RFDS assumes that solar energy development would be limited to approximately 700,000 acres, which is about 2% of the lands available under Alternative 2. Alternative 2 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria. Alternative 2 applies an additional 10% slope exclusion to further limit some additional impacts, and makes all remaining lands available for application. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Although ultimately the potential visual impacts for all alternatives would depend on the specific project locations and project characteristics, relative to the potential impacts under Alternative 1, the large reduction in lands available for applications under Alternative 2 would likely result in lesser impacts on scenic quality and SVRAs. Expected impacts under Alternative 2 would be further reduced by the exclusion of high slope areas, both because many SVRAs are in or near high-slope areas (e.g., mountain slopes or canyons) but also because the larger viewing angle of solar energy facilities in high slope areas would mean greater visibility from valley floors, plains and other flat areas, and many elevated viewing locations as well.

Of the total lands available for application under Alternative 2, approximately 25.8 million acres (74.4%) have pristine night skies. The remaining acreage (8.9 million acres, or 25.6%) are distributed through increasingly brighter skies, but strongly skewed toward pristine skies. Compared to the No Action Alternative and the other Action Alternatives, Alternative 2 would make a substantially smaller amount of lands with pristine night skies available for application than the No Action Alternative and Alternative 1, with a similar distribution among the ASB/NBSB ratios as those alternatives, but a greater skew toward pristine or near pristine night skies than Alternatives 3-5.

Alternative 3. Approximately 22.2 million acres of BLM-administered lands would be available for utility-scale solar application. While less than 1% of the acres available are Scenic Quality Class A, 4% are Class B and 7% are Class C (Table 5.19-1), the RFDS assumes that solar energy development would be limited to approximately 700,000 acres, which is about 3% of the lands available under Alternative 3. Alternative 3 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a 10% slope exclusion. Alternative 3 would also limit development to areas that are less than 10 miles from existing or planned transmission lines of >100 kV, focusing development in areas that may be more likely to be economically feasible for development. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Relative to the potential impacts under Alternatives 1 and 2, the further reduction in lands available for applications under Alternative 3 would likely result in lesser impacts on scenic quality and SVRAs. Expected impacts under Alternative 3 would be further reduced by limiting solar energy development to within 10 miles of existing or planned transmission lines of >100 kV, because at shorter distances the presence of existing transmission lines would have already reduced scenic quality or had impacts on nearby SVRAs. Adding solar energy facilities into areas where electric transmission would have already lowered scenic quality would, on average, be expected to have lower impacts than adding facilities into areas that would often have higher scenic quality because they lacked transmission lines.

Of the total lands available for application under Alternative 3, approximately 13.7 million acres (64.6%) have pristine night skies. The remaining acreage (7.5 million acres, or 35.4%) are distributed through increasingly brighter skies, but moderately skewed toward pristine skies. Compared to the No Action Alternative and the other Action Alternatives, Alternative 3 would make a substantially smaller amount of lands with pristine night skies available for application than the No Action Alternative and Alternatives 1 and 2, with a distribution among the ASB/NBSB ratios notably less skewed toward pristine night skies than those alternatives, and thus a relatively greater proportion of lands with brighter night skies. The increased proportion of lands with brighter night skies under Alternative 3 is likely a result of restricting available lands to those in proximity to transmission lines and associated infrastructure that may generate light pollution, e.g., substations, highways, and energy facilities.

Alternative 4. Approximately 11.2 million acres of BLM-administered lands would be available for utility-scale solar application. While less than 1% of the acres available are Scenic Quality Class A, 1% are Class B and 3% are Class C (Table 5.19-1), the RFDS assumes that solar energy development would be limited to approximately 700,000 acres, which is about 6% of the lands available under Alternative 4. Alternative 4 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria, a 10% slope exclusion, and limiting development to previously disturbed lands, limiting the area in which new land disturbance could occur. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Relative to the potential impacts under Alternatives 1, 2, and 3, the further reduction in lands available for applications under Alternative 4 would likely result in lesser impacts on scenic quality and SVRAs. Expected impacts under Alternative 4 would be further reduced by limiting development to previously disturbed lands, because these lands would likely already have reduced scenic quality. Adding solar energy facilities onto previously disturbed lands with lowered scenic quality would, on average, be expected to have lower impacts than adding facilities into more intact lands.

Of the total lands available for application under Alternative 4, approximately 5.8 million acres (54.5%) have pristine night skies. The remaining acreage (4.9 million acres, or 45.5%) are distributed through increasingly brighter skies. Compared to the No Action Alternative and the other Action Alternatives, Alternative 4 would make a substantially smaller amount of lands with pristine night skies available for application than the No Action Alternative and Alternatives 1-3, with a distribution among the ASB/NBSB ratios even less skewed toward pristine night skies than Alternative 3. The increased proportion of lands with brighter night skies under Alternative 4 is likely a result of further restricting available lands to those in previously disturbed areas, which, on average, would be more likely to be closer to existing infrastructure generating light pollution.

Alternative 5. Approximately 8.4 million acres of BLM-administered lands would be available for utility-scale solar application. While less than 1% of the acres available are Scenic Quality Class A, 1% are Class B and 2.3% are Class C (Table 5.19-1), the RFDS assumes that solar energy development would be limited to approximately 700,000 acres, which is about 8% the lands available under Alternative 5. Alternative 5 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria, and a 10% slope exclusion. Alternative 5 would also combine the requirement that development be limited to less than 10 miles from existing or planned transmission lines of >100 kV (from Alternative 3) with the requirement to limit development to previously disturbed lands (from Alternative 4), making it the alternative with the least lands available for solar ROW application. Alternative 5 provides a focus on areas that may be more likely to be economically feasible for development because they are near the transmission grid as well as limiting the amount of new land disturbance. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Relative to the potential impacts under Alternatives 1 through 4, the further reduction in lands available for applications under Alternative 5 would likely result in lesser impacts on scenic quality and SVRAs because it combines both impact reduction factors discussed for Alternatives 3 and 4.

Of the total lands available for application under Alternative 5, approximately 3.7 million acres (46.8%) have pristine night skies. The remaining acreage (4.2 million acres, or 53.2%) are distributed through increasingly brighter skies. Compared to the No Action Alternative and the other Action Alternatives, Alternative 5 would make the least amount of lands with pristine night skies available for application, with a distribution among the ASB/NBSB ratios generally similar to Alternative 4 but slightly skewed toward lands with brighter night skies. The increased proportion of available lands with brighter night skies under Alternative 5 is likely a result of combining the restrictions of Alternatives 3 and 4.

5.20 Water Resources

A utility-scale PV solar energy project can affect surface water and groundwater in several ways, including the use of water resources, modification of the natural surface water and groundwater flow systems, alteration of the interactions between groundwater and surface waters, contamination of aquifers, wastewater treatment either on- or offsite, and water quality degradation by runoff or withdrawals as well as from leaks and spills of fuels and chemicals used during construction and operation of the project. Section 5.20.1 identifies the types of impacts on water resources during activities conducted in various development phases of PV energy projects. Section 5.20.2 describes cumulative impacts on water resources from the PV energy project and existing and foreseeable future development.

5.20.1 Direct and Indirect Impacts

Direct and indirect impacts on water resources could occur from activities conducted during various development phases of a utility-scale PV solar energy project. This section discusses the potential impacts on both water quantity and quality associated with utility-scale PV solar energy project activities.

5.20.1.1 Site Characterization

As stated in Section 3.2.1, very little site modification is necessary during the site characterization phase. Site characterization activities could include surface hydrology assessment, floodplain mapping, and sensor placement. Remote or previously undeveloped sites may require development of minimal access roads. There is some potential for hydrologic modifications because of access road development. The impacts of these modifications on surface runoff and infiltration can be managed by adherence to state and local guidance for avoiding alteration in surface runoff intensity and timing. Any alteration of a waters of the United States would require a CWA Section 404 permit. Work crew size during site characterization would likely be small. Workers may need water for potable and sanitary purposes that may be transported to the site from offsite sources and sanitary wastes may be transported offsite to suitable locations. For most sites, impacts on water resources from site characterization activities would be insignificant.

5.20.1.2 Site Preparation

As stated in Section 3.2.2, site preparation would last a few months and may include site clearing, ground preparation, grading, and installing foundations, electrical equipment, and substations. These activities are likely to require heavy equipment like bulldozers, graders, excavators, scrapers, front-end loaders, trucks, cranes, rock drills, chain saws, chippers, trenching machines, and equipment for blasting operations if required. Construction techniques that minimize land surface disturbance, such as avoiding grading, leaving natural contours of the site in place, and mowing vegetation rather than removing it may be employed. These techniques would help minimize hydrologic alterations. Any alteration of a waters of the United States would require a CWA Section 404 permit. Because the area of disturbance during site preparation would be larger than that during site characterization, the potential for hydrologic modifications would be greater. Changes in surface runoff and infiltration characteristics could be managed with appropriate techniques, including installation of stormwater management features (e.g., drainage ditches, infiltration basins, retention or detention ponds). Water would be used for dust suppression over a larger area that is disturbed. Work crew size during site preparation would be larger. Workers may need water for potable and sanitary purposes that may be transported to the site from offsite sources. Portable latrines would provide sanitary facilities, and sanitary wastes may be transported offsite to suitable locations. For most sites, impacts on water resources from site preparation could range from insignificant to moderate. The impacts would be managed under applicable federal, state, and local permits and their requirements. Adherence to BMPs can minimize impacts on surface waters and groundwater.

5.20.1.3 Site Construction

As stated in Section 3.2.2, site construction would take longer—smaller solar energy facilities in the range of 5 to 50 MW may be constructed in 1 year or less, but larger facilities may have construction periods of several years. As stated in Section 3.2.3, site construction may include establishing site access; ground preparation of the solar field area (mowing and/or contouring); grading in some portions of the site; constructing temporary laydown and parking areas; constructing the solar field; constructing the operation and maintenance building, electrical substations, and meteorological towers (if not done during site characterization); and constructing linear facilities (an onsite road system, gen-tie lines and, for larger facilities, possibly water lines). Equipment used in the construction phase would include cranes, front-end loaders, backhoes, bulldozers, and trucks. Foundation excavation, foundation installation, and construction of structures for solar energy facilities would be performed. Excavated material may need to be stored onsite and may be re-applied to disturbed areas or for grading. If needed, concrete for these structures would likely be transported from offsite locations, so water use for concrete preparation is not assumed. Water could be needed for dust suppression and potable and sanitary use of the work crew. If large areas are cleared for solar fields, larger amount of water may be needed for dust suppression. Potable water may be obtained from nearby municipal sources or could be obtained from nearby surface water sources or from an onsite well. Portable latrines would provide sanitary facilities and sanitary wastes may be transported offsite to suitable locations.

As listed in Table 3.1-1, representative water use during construction of PV solar energy facilities can range from 0.12 to 3.8 ac-ft per MW. This representative water use would occur during the construction period, which can last from about a year for facilities of 50 MW or less to multiple years for larger facilities. The estimated construction water use for utility-scale solar energy facilities of 5 to 750 MW (range used for assessment; see Section 3.1.2) is from 0.6 to 19 ac-ft on the lower end to 90 to 2,850 ac-ft on the higher end. The degree of impact of construction water use on the water resources would depend on site-specific factors including water availability at and/or near the project site. Usually, a water use permit from the state or agreements with local agencies will be necessary to withdraw and use water for construction.

Hydrologic alterations from increase in impervious areas and regrading could potentially change surface drainage patterns and infiltration locations. The impacts of these alterations would need to be controlled following federal, state, and local requirements that protect downstream surface water features from changes in intensity and timing of runoff, water quality of runoff, and potential contamination of groundwater sources. At most sites, impacts on water resources from site construction would range from insignificant to moderate. The impacts would be managed under applicable federal, state, and local permits and their requirements. Adherence to BMPs can minimize impacts on surface waters and groundwater.

5.20.1.4 Operations and Maintenance

As stated in Section 3.2.4, operation of PV solar energy facilities would require a small number of onsite personnel, but the precise number would depend on the capacity of the facility (see Table 3.1-1). Hydrologic alterations made during construction of the facility would be in place during operations. Some disturbed areas may regrow vegetation. Changes to surface runoff and infiltration patterns would continue to be managed under applicable federal, state, and local permits and requirements. Stormwater management including use of detention or retention basins would continue minimizing changes to offsite runoff quantity and timing, water quality, and groundwater recharge and discharge characteristics. Water use during operations would include potable, sanitary, and panel washing needs. Offsite water sources or onsite groundwater and/or surface water could be used in the operations phase to meet project water needs. Groundwater withdrawals, if needed for the project, would cause a cone of depression around a pumping well or wells, which will expand until the rate of water extraction is balanced by the capture of groundwater that would otherwise discharge from the aquifer to springs or streams or be consumed by plants. Reaching an equilibrium between extraction and capture can take a long time.

The total water withdrawal (groundwater and surface water) for the 11 states based on 2015 data are provided in Table 4.20.3-2. As listed in Table 3.1-1, representative water use during operation of PV solar energy facilities ranges from 0.008 to 0.13 ac-ft/yr per MW. Other sources reported a water withdrawal of 0.05 to 0.35 ac-ft/yr per MW (DOE 2009; Jin et al. 2019). For this analysis, a range of 0.05 to 0.35 ac-ft/yr per MW for operations-related water withdrawals is assumed by selecting higher reported values of the low and high end of the range. As stated above, the source for this water could be an offsite source or available onsite surface and/or groundwaters. Therefore, the estimated water withdrawals for utility-scale solar energy facilities of 5 to 750 MW (Section 3.1.2) are 0.25 to 1.75 ac-ft/yr on the lower end to 36.9 to 263 ac-ft/yr on the higher end. The degree of impact of operations-related water use on the water resources would depend on site-specific factors including total amount of water needed for a facility and water availability at and/or near the project site. Usually, a water use permit from the state or agreements with local agencies will be necessary to withdraw and use water for operation.

During operations, there is a potential for water quality degradation from application of herbicides and pesticides, and accidental spills of chemicals and fuels that could contaminate surface water bodies and aquifers. While stormwater and wastewater discharges to surface water bodies may require a National Pollutant Discharge Elimination System permit, management of accidental spills may require a spill prevention and cleanup plan. Adherence to BMPs and all applicable permit requirements including monitoring, reporting, and remediation would help minimize impact on water resources. For most sites, impacts on water resources from operation of the solar energy project could range from insignificant to moderate.

5.20.1.5 Decommissioning

As stated in Section 3.2.5, decommissioning of a solar energy facility would include removal of most if not all equipment; removal of permanent structures and improvements (including onsite and access roads); proper closure of all onsite wells; removal of all hazardous materials and wastes and closure of related storage areas according to applicable requirements (including a separate closure plan for hazardous waste storage areas); remediation of all spills or leaks of chemicals that may occur during emptying or dismantlement of components; closure of all offsite material storage areas; and return of the site to its native state to the greatest extent possible, including re-establishment of the native vegetative communities.

Water use would cease after decommissioning the solar energy project. However, hydrologic alterations could still be in place, including regraded areas that affect surface runoff patterns, any redirected surface drainages, and filled excavations that alter groundwater pathways. After groundwater pumping stops, groundwater levels in the aquifer would start to recover and fill the cone of depression; however, depending on aquifer properties, this recovery may take a long time after decommissioning is completed. During this time, groundwater that otherwise would have discharged to springs or streams or adjacent aquifers instead goes into aquifer storage, so the capture of groundwater discharge may continue even though pumping has ceased. When water withdrawal from a surface water body stops, streamflow would return to preconstruction levels. However, the discharge of surface water from the reclaimed site may still be different that preconstruction condition depending on the size of disturbed and regraded area.

5.20.1.6 Transmission Lines and Roads

As stated in Section 3.2.6, construction and operation of transmission lines to tie solar energy facilities into the main power grid would be required for most new PV solar energy facilities. The length of transmission line required would depend on the distance from the site to existing lines. Water needs during construction would include water for potable use, vehicle washing, and dust suppression. Construction of transmission lines and access roads would result in ground disturbance and may result in altered surface runoff volume and timing, and potentially increased sediment load in surface runoff. The degree of impact would depend on site-specific factors, including ground slope, ground cover, and proximity to nearby surface water bodies. BMPs during construction activities could help reduce these impacts.

During operations, the impacts of hydrologic alterations would remain similar. Periodic inspection and maintenance of the cables and towers would be required. Impact on water resources from these activities are expected to be insignificant. As stated in Section 3.2.6, decommissioning of transmission lines and substations would include removal of all equipment and permanent structures, remediation of all spills or leaks of chemicals, and return of the ROW to its native state to the greatest extent possible, including re-establishment of native vegetative communities. Some hydrologic alteration may remain after decommissioning, including in areas that were graded or where streams may have been redirected.

5.20.2 Cumulative Impacts

Overall, the impacts on water supplies from PV facilities would likely be minor, since these facilities typically do not require large quantities of water, except during construction of larger facilities. However, site-specific conditions (e.g., a water supply well or spring located near the proposed withdrawal point) could result in larger incremental impacts and/or contribute to cumulative impacts on water resources. These considerations would need to be evaluated for each PV solar energy project using site-specific analyses. All new construction would require water for fugitive dust control. Larger PV solar energy facilities could require large volumes of water during construction to control dust emissions over large acreages.

Cumulative impacts on water supplies in the 11-state planning area from foreseeable development could range from small to moderately high. Impacts will be constrained by the limited availability of water rights and via oversight by state and local water authorities.

Table 2.2-2 lists the estimated BLM-administered lands needed for utility-scale solar energy development under the RFDS. To assess the potential impact of utility-scale PV solar energy projects within the 11-state planning area, a state-by-state estimate of operation-related water withdrawals was performed. Using the data in Tables 2.2-1, and assuming that (1) 75% of BLM-administered lands would be used for PV solar energy projects and (2) 7.5 ac of land would be needed for each MW of energy generation capacity, estimated water withdrawals for operating PV solar energy projects for each state are listed in Table 5.20-1. These operation-related water withdrawals were then compared to the 2015 statewide water withdrawals to assess the relative, incremental water withdrawal requirements of future utility-scale PV solar energy projects in each state.

Table 5.20-1. Estimated Water Withdrawals from PV Solar Energy Facilities for Each State

State	Estimated RFDS Power Generation on BLM-Administered Lands[a] (MW)	Estimated Water Withdrawals for Operation[b] (ac-ft/yr)		2015 Water Withdrawals		Estimated Water Withdrawals for Operation as a Percentage of 2015 Water Withdrawals	
		Min.	Max.	MGD	ac-ft/yr	Min.	Max.
Arizona	26,428	1,321	9,250	5,980	6,698,425	0.0197	0.1381
California	14,663	733	5,132	28,800	32,259,972	0.0023	0.0159
Colorado	6,028	301	2,110	10,300	11,537,421	0.0026	0.0183
Idaho	11,943	597	4,180	17,700	19,826,441	0.0030	0.0211
Montana	718	36	251	9,810	10,988,553	0.0003	0.0023
Nevada	6,416	321	2,246	2,960	3,315,608	0.0097	0.0677
New Mexico	1,483	74	519	2,900	3,248,400	0.0023	0.0160
Oregon	6,852	343	2,398	6,580	7,370,507	0.0046	0.0325
Utah	5,306	265	1,857	4,230	4,738,183	0.0056	0.0392
Washington	9,571	479	3,350	4,260	4,771,788	0.0100	0.0702
Wyoming	3,634	182	1,272	8,140	9,117,923	0.0020	0.0139
Total	**93,041**	**4,652**	**32,564**	**101,660**	**113,873,220**	**0.0041**	**0.0286**

[a] Power generation was estimated assuming the BLM-administered acres developed presented in Table 2.2-1 and 7.5 ac land area required for each MW.

[b] Minimum and maximum estimated water withdrawals are based on 0.05 and 0.35 ac-ft/yr per MW of energy generation capacity

The maximum water withdrawal for the RFDS as a percentage of 2015 statewide water withdrawals would be 0.14% for Arizona. This level of incremental water use assumes that all PV projects in the RFDS would be developed and operated at the same time. The statewide fractions of the incremental estimated water use appear to be small. However, each PV solar energy project would also impact water resources in its vicinity. Depending on water availability at specific sites, the impacts may be different (both larger and smaller than the statewide impact). A site-specific water use impacts analysis should be performed in assessing each application for a PV solar energy project to assess the local impact on water resources.

Maximum construction-related water use can be 1,463 ac-ft/yr for a 750-MW PV solar energy project using the upper end of the construction-related water use (3.9 ac-ft per MW) and assuming that the construction period would be two years. This water use is bounded by the maximum operations-related water use shown in Table 5.20-1, except for Montana, New Mexico, and Wyoming. For New Mexico and Wyoming, construction-related maximum estimated water use of a single 750-MW PV solar energy project would be 0.045% and 0.016% of the 2015 statewide withdrawals. For Montana, a single 718-MW PV solar energy project would use an estimated maximum of 1,400 ac-ft/yr during construction, which would be 0.042% of the 2015 statewide withdrawals. Because construction and operation of a PV solar energy project would not overlap, the incremental impact of construction-related water use to cumulative, statewide impacts on water resources are likely to be minor.

As described above, large withdrawals due to solar energy demands are not expected under the RFDS, given state and local oversight of groundwater supplies and fully allocated supplies in most regions. However, pressure on water supplies will continue to grow from multiple demands. In addition, changes in regional precipitation and temperature that have been attributed to global climate change are expected to reduce total water supplies in the southwestern United States (USGCRP 2018). While states continue to consider further development of new water sources, some water demand will be met by increased reuse of municipal wastewater and water conservation measures will be increasingly applied.

5.20.3 Design Features

The BLM has identified design features that will be requirements for all utility-scale solar energy projects on BLM-administered lands subject to the ROD for this Programmatic EIS. The list of design features that have been identified to avoid, minimize, and/or compensate for potential impacts on water resources from solar energy development can be found in Appendix B.20.

5.20.4 Comparison of Alternatives

As described in Section 5.20.1, statewide operations-related water withdrawals were estimated for all 11 states in the planning area. The estimated water withdrawals are based on two assumptions: (1) 7.5 acres of land would be needed for each MW of energy generation capacity and (2) operation-related water withdrawal for PV solar energy generation facilities ranges from 0.05 to 0.35 ac-ft/yr per MW. As listed in Table 3.1-1, construction-related water use for PV solar energy facilities ranges from 0.12 to 3.8 ac-ft per MW of energy generation capacity. Therefore, for this Programmatic EIS, both estimated construction-related and operations-related water uses are based on generation capacity which, in turn, is estimated from available land area. Because the available land area for development under the RFDS is the same for all Action Alternatives, there would be no difference in water use between Action Alternatives.

5.20.4.1 No Action Alternative

Under the No Action Alternative, approximately 47.3 million acres of BLM-administered lands would be available for applications for solar energy development. Of the total BLM-administered lands available for application, 330,195 acres are located within existing priority areas, approximately 15.7 million acres are variance lands allocated in the 2012 Western Solar Plan for the six-state planning area, and approximately 31.6 million acres would be available for application within the five additional states considered in this Programmatic EIS, as these lands were not addressed in the 2012 Western Solar Plan. However, solar energy development is expected to occur only on approximately 700,000 acres (the RFDS value), or 1.4% of BLM-administered lands available for solar ROW application under the No Action Alternative. Water resources impacts described in Section 5.20.1 could occur from the construction and operation of PV solar energy facilities under the No Action Alternative. In the six states addressed under the 2012 Western Solar Plan, the design features from that plan would mitigate impacts on water resources. In the five new states, required mitigation measures for impacts on water resources would be established at the project-specific level.

5.20.4.2 Action Alternatives

Alternative 1. Approximately 55 million acres of BLM-administered lands would be available for utility-scale solar application.

Alternative 2. Approximately 36.2 million acres of BLM-administered lands would be available for utility-scale solar application.

Alternative 3. Approximately 22.2 million acres of BLM-administered lands would be available for utility-scale solar application.

Alternative 4. Approximately 11.2 million acres of BLM-administered lands would be available for utility-scale solar application.

Alternative 5. Approximately 8.4 million acres of BLM-administered lands would be available for utility-scale solar application.

The RFDS estimates that solar energy development would occur only on approximately 700,000 acres within BLM-administered lands available under Alternatives 1 through 5. Impacts on water resources described in Section 5.20.1 could occur from the construction and operation of PV solar energy facilities under the Action Alternatives. The magnitude of impacts on water resources from development to the RFDS level on BLM-administered lands within the planning area would depend on the location of solar energy development. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

5.21 Wildland Fire

5.21.1 Direct and Indirect Impacts

Significant impacts could occur in areas designated with high burn probability and CFWI values (also known as the Fire Weather Index, or FWI) due to solar energy development and operation. Across the 11-state planning area, established fire regimes and protocols are in place to help mitigate wildland fire risk, lessening potential impacts related to solar energy development. Special considerations should be taken when choosing a development area with respect to projected increases in CFWI by the mid-21st century, as detailed in Section 4.21. Wildland fire activity presents impacts throughout all phases of solar energy facility development, from construction through operation and decommissioning. These impacts are both direct (affecting the land, equipment, and personnel at the solar energy facility site) and indirect (potentially affecting nearby lands and communities through spread of wildland fires). Specific impacts through each phase of solar energy facility development and operation are discussed below.

5.21.1.1 Construction

Many areas within the 11-state planning area are susceptible to wildland fires, with more lands projected to see an increased fire risk by the mid-21st century. Solar energy facilities by design eliminate flammable vegetation sources within the development perimeter, thus posing little threat to increased fire risk during their operation. Site proposals generally call for vegetative removal from the entire solar field area, at a minimum requiring all vegetation to be cleared from substation and power-block areas to eliminate fire risk. During construction, construction equipment, vehicles, combustible materials, and necessary fuels all present increased fire risk. These safety risks are typically addressed through the removal of vegetation from active construction areas to limit potential fuel sources. Other common practices to address fire risk involve proper and well-maintained storage for fuels and combustible materials, suspension of activities during weather conditions that enhance fire risk, limits to the amounts of flammable materials onsite, and proper disposal of biomass. Training for crews and site operators on proper use of their equipment also aids in mitigating potential fire risks due to electrical and welding hazards. Before construction, a site-specific plan should be developed to identify potential wildfire risks and potential mitigation strategies, one example being a document containing a full burn plan for biomass removal.

Construction crews also should work with local firefighters in developing wildfire mitigation and prevention strategies. The use of heavy equipment provides an avenue for crews to help firefighters mitigate the spread of wildfires in some situations, along with aiding in post-fire cleanup. Building materials that use petroleum or plastic present significant indirect impacts on construction crews, firefighters, and surrounding communities because they release toxic fumes when burned. These impacts extend beyond the wildfire event, with some toxic fumes and smoke being carried downwind and the potential for impacts on those tasked with tearing down and post-fire cleanup. Consideration should be given to the use of construction materials that are resistant to fire or non-toxic.

5.21.1.2 Operation

During site operation, electrical substations present a potential fire risk due to modification of voltage and current of generated electrical power to be compatible with connected grid conditions. Also, depending on the system used, excess heat may be generated, requiring a cooling system for removal. Failure of this cooling system poses an increased fire risk. Biomass disposal through burning may also present a risk, which can be mitigated based on methods prescribed by a site-specific fire burn plan. Any solar energy facility can indirectly create an increased fire risk due to the operation of internal combustion vehicles and equipment in enhanced fire risk weather conditions (hot, low humidity, windy). Mitigation methods for each potential risk must be addressed through a site-specific fire safety and management plan developed in conjunction with the BLM, local and state governments, and local fire and emergency management services.

PV systems present the opportunity for increased wildfire risk during operation. A study conducted by European testing and certification company TÜV Rheinland found that in more than half of cases involving fire damage in PV systems, the system itself was the probable cause (Sepanski et al. 2018). Most fires that occur due to PV systems are considered serious fires, meaning they are difficult to extinguish and can spread beyond the area of origin. In PV systems, the major causes of fires are due to an error in system design, a faulty or defective product, or poor installation practices. BES presents a substantial risk in both generating fires (due to the high heat associated with lithium-ion battery operation) and during a wildfire event (due to potential hazards from toxic chemical leakage and potential explosion of chemical agents). A fire during site operation could cause significant economic losses at the site (due to equipment damage), and potentially in surrounding areas. As the risk of wildfires increases under future climate scenarios, operators of solar energy facilities need to be more proactive in managing onsite fire risks. Management methods can include regular testing of solar systems and equipment by independent third parties, standardization of quality assurance measures, prompt replacement of defective or aged components, and incorporation of strict safety plans and components across the site.

5.21.1.3 Transmission Lines and Roads

Building additional roads to both provide access to solar energy sites and support construction and maintenance of the facilities can increase fire risk due to increased human activity and vehicle traffic. While the risk of fuel spillage is low from an increase in vehicle traffic, vehicles could inadvertently increase fire risk through the introduction of weeds and non-native plant species to the solar energy site. Introduction of non-native plant species can lead to a destabilization of native vegetation communities, increasing the risk of fire-tolerant species becoming dominant. This would lead to an increase in both wildland fire size and spread as these species will provide more abundant flash fuels. Plans would need to address measures to avoid this, such as power washing vehicles before entering a site, parking vehicles in designated areas, equipping vehicles with fire suppression technology, etc. Due to the wide variety of areas in which solar energy development could occur, assessment of fire risk needs to be performed at a site-specific level to consider vegetation type and density, historical fire patterns, future predicted CFWI trends, and any other factors that could affect wildland fire risk. If wildland fire activity were to increase, this would increase fire suppression costs and the necessity for the BLM and fire organizations to respond and perform fire suppression measures. The building of roads does help potential mitigation measures, as they can act as a barrier preventing fire spread.

Transmission lines present an increased fire risk while operational due to electrical currents and the resulting extreme heat emitted from malfunctioning equipment. While being placed down, transmission lines do not increase fire risk, and in some cases may mitigate fire risk as vegetation and trees are cleared to prevent potential ground faults. Ground faulting of energized conductors against their support poles, other energized conductors, vegetation, structures, or other ground obstacles will increase fire risk. Typically, these designs incorporate lightning protection; however, due to their electrical charge, they naturally attract lightning strikes, leading to an increased fire risk for surrounding areas. Other potential causes of increased fire risk include the risk of downed lines when connecting with overhead grid systems, electrical equipment failure, or the occurrence of high-energy arcs. When planning the placement of transmission lines, careful attention will need to be given as to future CFWI trends and areas with a high burn probability. If a wildfire were to impact transmission lines, this would not only provide substantial economic losses to solar energy facilities (due to the need to replace transmission lines), but it would also impact nearby areas that use the transmitted energy from the solar energy facility. The smoke and hot gases from wildfires also pose a risk while creating a conductive path for electricity. Electricity can arc from transmission lines through the created conductive path, endangering nearby people and objects.

5.21.1.4 Decommissioning

Decommissioning activities could cause a slight increase in wildfire activity at a former site location and mitigation measures must be carefully considered before any action is taken. The removal of PV components presents a risk of wildfire occurrence through accidental release of flammable material and chemicals (such as from BES components). Crews performing the removal of materials must work with local fire and emergency management agencies to put measures into place to reduce fire risk and have tools (such as fire extinguishers) readily available to control a fire if one should start. Upon removal, roads and transmission lines may need to be dug up at certain sites. There is substantial potential for introduction of invasive and non-native species during this process. A plan must be put in place to clean all equipment before and after use to prevent any introduction of weeds.

5.21.2 Cumulative Impacts

Solar energy facilities increase wildfire potential during construction and throughout operation. Areas suitable for solar energy development are already under stress from wildfires, with most projected to see a greater number of wildfire events in the coming decades. Flammable vegetation sources, especially invasive species, present the highest wildfire risk at solar energy facilities. During development, risk can be mitigated if vegetation is monitored and care taken for all equipment, vehicles, and personnel entering the site to prevent any invasive species from being unknowingly introduced. Generation, storage, and transmission of electrical power also present increased wildfire risks at and around solar energy facilities. Under the RFDS, the BLM estimates that a total combined area of approximately 700,000 acres of BLM-administered lands and 600,000 acres of other lands (including private lands and state-owned lands) across the 11-state planning area will host utility-scale PV solar energy development over the next 20 years, which could cause cumulative impacts through a direct and substantial increase in wildfire activity. Other uses of BLM-administered lands as well as nearby federal, private, or state lands, could contribute to cumulative impacts if they increase risk for wildfire events. Wildfire activity can easily spread, meaning increased activity at a site would negatively impact nearby lands and communities. Proper adherence to all site design features, especially established fire regimes and protocols, are key to minimizing all potential impacts on wildfire activity. Due to projected increases in wildfire activity, established fire regimes, protocols, and design features will need to be re-evaluated over time as current cumulative conditions change.

5.21.3 Design Features

The BLM has identified design features that will be requirements for all utility-scale solar energy projects on BLM-administered lands subject to the ROD for this Programmatic EIS. The list of design features that have been identified to avoid, minimize, and/or compensate for potential impacts on wildland fires from solar energy development can be found in Appendix B.21.

5.21.4 Comparison of Alternatives

5.21.4.1 No Action Alternative

Under the No Action Alternative, approximately 47.3 million acres of BLM-administered lands would be available for applications for solar energy development. Of the total lands available for application, 330,195 acres are located within existing priority areas, approximately 15.7 million acres are variance lands allocated in the 2012 Western Solar Plan for the six-state planning area, and approximately 31.6 million acres would be available for application within the five additional states considered in this Programmatic EIS, as these lands were not addressed in the 2012 Western Solar Plan. However, solar energy development is expected to occur only on approximately 700,000 acres (the RFDS value), or 1.4% of BLM-administered lands available for solar ROW application under the No Action Alternative.

5.21.4.2 Action Alternatives

Alternative 1. Approximately 55 million acres of BLM-administered lands would be available for utility-scale solar ROW application. The RFDS estimates that solar energy development would occur only on approximately 700,000 acres within BLM-administered lands available under Alternative 1. Wildland fire impacts described in Section 5.21.1 may occur from the construction and operation and decommissioning of PV solar energy facilities. In the last 20 years, Washington, Idaho, and California have been the most impacted by wildland fires (Table 5.21-1). More than 35% (156,000 acres) of the land available in Washington under this alternative has burned in the last 20 years and almost 8% of lands in Idaho and California available under this alternative have burned in wildland fire events. In total, 2.4% (3.8 million acres) of the lands available under Alternative 1 have burned during the last 20 years. As these lands have burned within the last 20 years, there is a higher probability that they will burn again due to wildland fires. Consideration will need to be taken to prevent invasive and fire-resistant species from overtaking BLM-administered lands, these lands where fires have occurred being identified in Table F.21.3-2 and Figure F.21.3-2. Proper mitigation measures will need to be implemented and followed to prevent increased burn frequency and avoid the identified impacts at both the solar energy facility and surrounding lands. Combining this knowledge of historic fire occurrence with changes in CFWI and burn probability, land managers and planners can identify potential risk areas. Areas with an increased CFWI by the mid-century and high burn probability are the most susceptible lands for future fire occurrence. Cross-referencing these lands with the historic 20-year burn data may identify areas that would not be suitable for solar energy facility construction, or identify applicable mitigation measures to decrease this risk.

Alternative 1 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria, while making all other lands available for application. Alternative 1 would make more lands available for application than are currently available under the No Action Alternative.

Alternative 2. Approximately 36.2 million acres of BLM-administered lands would be available for utility-scale solar ROW application. The RFDS estimates that solar energy development would occur only on approximately 700,000 acres within BLM-administered lands available under Alternative 2. Wildland fire impacts described in Section 5.21.1 may occur from the construction and operation and decommissioning of PV solar energy facilities. In the last 20 years, Washington and Idaho have been the most impacted by wildland fires (Table 5.21-1). Approximately 11% (48,000 acres) of the land available in Washington under this alternative has burned in the last 20 years and 7% (830,000 acres) of land in Idaho available under this alternative has burned in wildland fire events. In total, 1.2% (1.9 million acres) of the lands available under Alternative 2 have burned during the last 20 years. As these lands have burned within the last 20 years, there is a higher probability that they will burn again due to wildland fires. Consideration will need to be taken to prevent invasive and fire-resistant species from overtaking BLM-administered lands, these lands where fires have occurred being identified in Table F.21.3-3 and Figure F.21.3-3. See mitigation measures discussion as under Alternative 1.

Table 5.21-1. Acreage Burned in 20 Years (2003–2022) Under All Alternatives

State	All BLM- Land (minus DRECP/ CDCA)	All BLM-Administered Land		Available Land Under Alternative 1		Available Land Under Alternative 2		Available Land Under Alternative 3		Available Land Under Alternative 4		Available Land Under Alternative 5	
		Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Arizona	12,109,337	424,971	3.5	65,760	0.5%	14,830	0.1%	8,580	0.07%	4,138	0.03%	3,774	0.03%
California	4,150,345	1,149,830	27.7	306,668	7.4%	13,063	0.3%	7,779	0.19%	5,313	0.13%	3,419	0.08%
Colorado	8,354,306	379,889	4.5	100,841	1.2%	19,759	0.2%	12,831	0.15%	5,607	0.07%	4,524	0.05%
Idaho	11,774,992	3,143,944	26.7	1,030,407	8.8%	833,684	7.1%	643,469	5.46%	300,952	2.56%	275,744	2.34%
Montana	8,043,025	394,353	4.9	65,569	0.8%	9,629	0.1%	1,958	0.02%	2,973	0.04%	609	0.01%
Nevada	47,272,125	4,570,715	9.7	783,432	1.7%	359,371	0.8%	258,483	0.55%	57,639	0.12%	48,886	0.10%
New Mexico	13,493,392	268,926	2.0	106,840	0.8%	55,220	0.4%	7,281	0.05%	8,974	0.07%	2,279	0.02%
Oregon	15,718,197	2,709,710	17.2	406,727	2.6%	123,810	0.8%	41,253	0.26%	24,202	0.15%	19,600	0.12%
Utah	22,767,896	1,175,120	5.2	734,106	3.2%	360,635	1.6%	232,360	1.02%	149,155	0.66%	100,927	0.44%
Washington	437,237	185,123	42.3	156,003	35.7%	48,403	11.1%	36,127	8.26%	31,007	7.09%	23,051	5.27%
Wyoming	18,047,498	275,270	1.5	65,239	0.4%	32,773	0.2%	16,813	0.09%	17,045	0.09%	11,517	0.06%
Westwide	162,168,351	14,677,851	9.1	3,821,591	2.4%	1,871,178	1.2%	1,266,936	0.78%	607,005	0.37%	494,330	0.30%

Alternative 2 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria. Alternative 2 applies an additional 10% slope exclusion to further limit some additional impacts, and makes all remaining lands available for application. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 3. Approximately 22.2 million acres of BLM-administered lands would be available for utility-scale solar ROW application. The RFDS estimates that solar energy development would occur only on approximately 700,000 acres within BLM-administered lands available under Alternative 3. Wildland fire impacts described in Section 5.21.1 may occur from the construction and operation and decommissioning of PV solar energy facilities. In the last 20 years, Washington and Idaho have been the most impacted by wildland fires (Table F.21-1). Approximately 8% (36,000 acres) of the land available in Washington under this alternative has burned in the last 20 years and 5% (640,000 acres) of lands in Idaho available under this alternative have burned in wildland fire events. In total, 0.8% (1.3 million acres) of the lands available under Alternative 3 have burned during the last 20 years. As these lands have burned within the last 20 years, there is a higher probability that they will burn again due to wildland fires. Consideration will need to be taken to prevent invasive and fire-resistant species from overtaking BLM-administered lands, these lands where fires have occurred being identified in Table F.21.3-4 and Figure F.21.3-4. See design feature discussion as under Alternative 1.

Alternative 3 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria and a 10% slope exclusion. Alternative 3 would also limit development to areas that are less than 10 miles from existing or planned transmission lines of >100 kV, focusing development in areas that may be more likely to be economically feasible for development. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 4. Approximately 11.2 million acres of BLM-administered lands would be available for utility-scale solar ROW application. The RFDS estimates that solar energy development would occur only on approximately 700,000 acres within BLM-administered lands available under Alternative 4. Wildland fire impacts described in Section 5.21.1 may occur from the construction and operation and decommissioning of PV solar energy facilities. In the last 20 years, Washington and Idaho have been the most impacted by wildland fires (Table F.21-1). Approximately 7% (31,000 acres) of the land available in Washington under this alternative has burned in the last 20 years and 3% (300,000 acres) of lands in Idaho available under this alternative have burned in wildland fire events. In total, 0.4% (600,000 acres) of the lands available under Alternative 4 have burned during the last 20 years. As these lands have burned within the last 20 years, there is a higher probability that they will burn again due to wildland fires. Consideration will need to be taken to prevent invasive and fire-resistant species from overtaking BLM-administered lands, these lands where fires have occurred being identified in Table F.21.3-5 and Figure F.21.3-5. See mitigation measures discussion as under Alternative 1.

Alternative 4 would help the BLM to meet its energy goals by focusing development into areas avoiding resource conflicts through resource-based exclusion criteria, a 10% slope exclusion, and limiting development to previously disturbed lands, limiting the area in which new land disturbance could occur. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

Alternative 5. Approximately 8.4 million acres of BLM-administered lands would be available for utility-scale solar ROW application. The RFDS estimates that solar energy development would occur only on approximately 700,000 acres within BLM-administered lands available under Alternative 5. Wildland fire impacts described in Section 5.21.1 may occur from the construction and operation and decommissioning of PV solar energy facilities. In the last 20 years, Washington and Idaho have been the most impacted by wildland fires (Table F.21-1). Approximately 5% (23,000 acres) of the land available in Washington under this alternative has burned in the last 20 years and 2% (275,000 acres) of lands in Idaho available under this alternative have burned in wildland fire events. In total, 0.3% (500,000 acres) of the lands available under Alternative 5 have burned during the last 20 years. As these lands have burned within the last 20 years, there is a higher probability that they will burn again due to wildland fires. Consideration will need to be taken to prevent invasive and fire-resistant species from overtaking BLM-administered lands, these lands where fires have occurred being identified in Table F.21.3-6 and Figure F.21.3-6. See mitigation measures discussion as under Alternative 1.

Alternative 5 would also combine the requirement that development be limited to less than 10 miles from existing or planned transmission lines of >100 kV (from Alternative 3) with the requirement to limit development to previously disturbed lands (from Alternative 4), making it the alternative with the least lands available for solar ROW application. Alternative 5 provides a focus on areas that may be more likely to be economically feasible for development because they are near the transmission grid as well as limiting the amount of new land disturbance. Updated and more prescriptive design features may reduce the magnitude of impacts in comparison with the No Action Alternative, especially in the five new states where 2012 Western Solar Plan design features are not currently applicable.

5.22 Other NEPA Considerations

5.22.1 Unavoidable Adverse Impacts

Utility-scale solar energy development under the Action Alternatives and under the No Action Alternative would result in some unavoidable adverse impacts, as follows:

- Short-term air quality impacts due to dust generated during site preparation and construction, and noise impacts due to the use of heavy construction equipment;
- Short-term influx of workers and transportation-related impacts (e.g., increased traffic) during the construction phase;
- Long-term loss of permitted grazing;
- Long-term loss of public access;
- Long-term loss of soil, vegetation, and habitat for wildlife (including sensitive species);
- Long-term impacts on some species, both at the population level and on individual organisms; and
- Long-term visual impacts on residents of communities near solar energy facilities, users of roads passing near solar energy facilities, and patrons of specially designated areas within the viewshed of solar energy facilities.

To some degree, the magnitude of these adverse impacts depends on the specific project and is decreased by implementing the programmatic design features (e.g., siting facilities away from the most sensitive resources), although the extent to which these impacts could be mitigated cannot be assessed except at the project level, and some of these impacts cannot be completely avoided.

5.22.2 Short-Term Use of the Environment and Long-Term Productivity

For this assessment, short-term uses are defined as those occurring over a 2- to 3-year period, generally applicable to site characterization/preparation and construction phases. Long-term uses and productivity are those that occur throughout the time frame considered in this Programmatic EIS (approximately 20 years through 2045).

Although land disturbance within solar energy generation facility ROWs would be long term, additional areas affected during the construction of the generation facilities and related infrastructure (e.g., roads, transmission lines, and natural gas or water pipelines) would result in relatively short-term disturbance. Land clearing and grading and construction and operation activities would disturb surface soils and wildlife and their habitats, and affect local air and water quality, visual resources, and noise levels within and around the solar energy facility areas and on additional lands used for project-related infrastructure. Short-term influxes of construction workers would affect the local socioeconomic setting.

The lands used long term for solar energy facilities would produce electricity generated from a renewable source and would result in reduced emissions of GHGs and combustion-related pollutants, assuming the solar energy facilities avoid electricity generated by fossil fuel power plants. These facilities would generate stable jobs and income for nearby communities (although at a lower rate than during the short-term construction phase), sales and income tax revenues, and income for the federal government in the form of ROW rental revenues over the life of the projects.

Remediation and restoration required through programmatic design features (and funded through required bonding of the projects) ensures that BLM-administered lands no longer needed for PV solar energy generation in the future would be returned to pre-construction conditions to the greatest extent possible.

5.22.3 Irreversible and Irretrievable Commitment of Resources

Solar energy development on BLM-administered lands would result in the consumption of sands, gravels, and other geologic resources as well as fuel, structural steel, and other materials, some of them special-use materials (i.e., metals used in PV solar cells). At decommissioning, some of these materials would be available for reuse.

Water resources would be consumed mainly during the construction phase with a small amount of water used during operations for panel washing and potable purposes; this water use would be an irreversible and irretrievable loss.

For most plant and animal species, population-level impacts would be unlikely, based on the assumption that required design features are implemented; however, population-level impacts are possible for some species. In addition, during construction, operation, and decommissioning, individual plants and animals would be affected. Site- and species-specific analyses conducted at the project level for all project phases would help ensure that the potential for such impacts would be minimized to the fullest extent possible. There would be long-term reductions in habitat due to fencing of large areas during the operational period; this impact would be partially mitigated through siting in locations that do not contain critical habitat, use of wildlife-friendly fencing, and providing corridors for wildlife passage where applicable. Additional programmatic policies (e.g., requiring long-term monitoring and related additional mitigation) and design features would reduce the impacts over time. However, it is unknown whether irreversible and irretrievable impacts on species would occur.

Cultural and paleontological resources are nonrenewable. Impacts on these resources would constitute an irreversible and irretrievable commitment; however, implementation of the programmatic design features would minimize the potential for these impacts to the extent possible.

Impacts on visual resources in specific locations could constitute an irreversible and irretrievable commitment. Implementation of the programmatic design features would minimize the potential for these impacts to the extent possible; additional mitigation efforts would be undertaken at the project level with stakeholder input.

5.22.4 Mitigation of Adverse Impacts

An extensive set of required programmatic design features addressing impacts on important resources and resource uses from solar energy development is presented in Appendix B. These design features would be implemented for all solar energy facilities issued ROW authorizations on BLM-administered lands under this Solar Programmatic EIS. This comprehensive set of design features would ensure that impacts from PV solar energy development on BLM-administered lands would be mitigated to the fullest extent possible. Any potential adverse impacts that could not be addressed at the programmatic level would be addressed at the project level, where resolution of site- and species-specific concerns is more readily achievable.

Under the Action Alternatives, the BLM would incorporate adaptive management strategies to ensure that new data and lessons learned about the impacts of solar energy projects would be used to avoid, minimize, or otherwise mitigate impacts to acceptable levels. The design features would be updated and revised as new data on the impacts of PV solar energy development become available.

6 Consultation, Coordination, and Public Engagement

6.1 Public Scoping

The BLM sponsored a public scoping period to support preparation of this Programmatic EIS. During the scoping period the BLM solicited comments on the development of the Programmatic EIS, including its overall scope and objectives.

The BLM published a NOI to prepare a Programmatic EIS to Evaluate Utility-Scale Solar Energy Planning and Amend Resource Management Plans for Renewable Energy Development in the *Federal Register* on December 8, 2022 (87 FR 75284). The NOI specifically sought public comment on whether the BLM should expand this planning effort to include five additional states: Idaho, Montana, Oregon, Washington, and Wyoming. In the NOI, the BLM noted that it would consider the extent to which lands covered by the DRECP may be included in the planning area. After consideration, the BLM chose not to include the area under the DRECP in the current effort as the BLM continues to believe the DRECP supports an acceptable balance between conservation and renewable energy opportunities within its planning area boundary. The BLM also sought public comment on the definition of utility-scale, the variance process, and incentivization of development in preferred areas. The NOI explained that the end date of the public scoping period would be February 6, 2023, or 15 days after the last public scoping meeting, whichever occurred later. The last public meeting was held on February 14, 2023. Therefore, public scoping closed on March 1, 2023. The public scoping period lasted a total of 84 days.

The public was offered four methods for submitting scoping comments or suggestions about the Programmatic EIS:

- The online comment form on the project website;
- Email;
- Mail; and
- Open public scoping meetings.

The BLM hosted 15 public scoping meetings: three virtual meetings and 12 in-person meetings (Table 6.1). The purpose of these meetings was to inform the public about the project and to provide an opportunity for individuals to submit oral comments. Table 6.1 summarizes the scoping meeting dates, locations, and number of attendees.

Table 6.1. Scoping Meeting Information

Meeting Date and Time[1]	Meeting Location	Approximate Number of Attendees
January 12, 2023, 12:30–3:30 pm	Virtual webinar via Zoom	242
January 13, 2023, 9 am–1 pm	Stewart Lee Udall Building, Washington DC	15
January 18, 2023, 10 am–2 pm	Courtyard Marriott, Sacramento, CA	20
January 19, 2023, 3–7 pm	Reno-Sparks Convention Center, Reno, NV	19
January 24, 2023, 3–7 pm	Southeast Regional Library, Gilbert, AZ	22
January 26, 2023, 3–7 pm	Crowne Plaza, Albuquerque, NM	9
January 30, 2023, 3–7 pm	Spokane Convention Center, Spokane, WA	5
January 31, 2023, 3–7 pm	Holiday Inn Express Boise-University Area, Boise, ID	16
January 31, 2023, 3–7 pm	Laramie County Community College, Cheyenne, WY	27
February 2, 2023, 3–7 pm	DoubleTree by Hilton, Bend, OR	46
February 2, 2023, 3–7 pm	Billings Hotel & Convention Center, Billings, MT	15
February 7, 2023, 12–4 pm	BLM Utah State Office, Salt Lake City, UT	34
February 9, 2023, 3–7 pm	Grand Junction Convention Center, Grand Junction, CO	23
February 13, 2023, 12:30–3:30 pm	Virtual webinar via Zoom	202
February 14, 2023, 9–11:30 am PST	Virtual webinar via Zoom	123

[1]All times are Mountain Standard Time (MST), unless noted as Pacific Standard Time (PST).

The BLM received 297 unique written submittals and heard 75 oral comments at the public meetings, resulting in 2,026 unique comments received during the scoping period. Many of the unique comments received during the scoping process responded to issues and questions posed by the BLM in the NOI (42%) and the NEPA process (23%). The remaining comments were about resource-specific concerns. The scoping summary report and copies of all written comments submitted by email, mail, or online comment form are available on the project website (https://eplanning.blm.gov/eplanning-ui/project/2022371/510). Transcripts from the public meetings are also available on the website.

In addition to unique submissions from individuals and organizations, several organizations asked their members to submit form letters (called “campaign” letters in the Scoping Summary Report). Nine different campaign letters associated with six different organizations were received; a summary of issues raised in the campaign letters is provided in Table 3 of the Scoping Summary Report, and a copy of each of the nine letters is available in Appendix A of that report. In total, 22,925 campaign letters were received.

6.2 Government-to-Government Consultation

The federal government works on a Government-to-Government basis with federally recognized Tribes. Under E.O. 13175 and President of the United States Memorandum on Consultation and Strengthening Nation-to-Nation Relationships (2021), federal agencies have an obligation to conduct formal Government-to-Government consultation with federally recognized Tribes. As a matter of practice, the BLM engages in consultation with all Tribal governments, associated Native communities and Tribal organizations, and Tribal individuals whose interests might be directly and substantially affected by activities on public lands. BLM Manual 1780 (BLM 2016k) provides further guidance for Tribal consultation. See Section 4.18 for a list of other federal laws and DOI guidance that require the BLM to consult on any actions on federally administered lands that may have the potential to affect Tribal cultural and natural resources of importance. The BLM has given substantial consideration to effective Government-to-Government consultations for this project in order to provide multiple opportunities for Tribal consultation.

In December 2022, BLM headquarters sent letters to 241 Tribes, chapters, and bands identified by the state offices, inviting those Tribes to be cooperating parties and offering to engage in Government-to-Government consultation. Two Tribal informational webinars were held on May 8 and June 14, 2023, to inform interested Tribes about the Programmatic EIS and ways to participate. One Tribe responded by email to request additional information prior to the webinars, and an informal teleconference was held between the BLM and the Tribe on May 2, 2023.

A list of Tribes contacted during the initiation of this Programmatic EIS is available in Appendix D. As of December 2023, one written response had been received from a Tribe. Additionally, two inquiries were received from Tribes via the State offices, and three Tribes were briefed as part of a state office yearly project briefing. As consultation will be an ongoing effort, Appendix D will be expanded in the final Programmatic EIS to include a summary of concerns and comments raised throughout the NEPA process.

Government-to-Government consultation for the Solar Programmatic EIS is ongoing. The BLM will continue to consult with interested Tribes and will continue to keep all Tribal entities informed about the Programmatic EIS. In addition, the BLM will continue to implement Government-to-Government consultation for all site-specific solar energy development projects on BLM-administered lands with interested and affected Tribes (according to the locations of the projects on a case-by-case basis).

6.3 Coordination of BLM State and Field Offices

This Programmatic EIS was prepared by the BLM headquarters office to evaluate a program that will determine how solar energy development is administered in each of the 11 states in the planning area. In 2022 the BLM established Renewable Energy Coordination Offices (RECOs) pursuant to the Energy Act of 2020. The national RECO within BLM headquarters maintains program oversight by providing direction and guidance while the state and regional RECOs support the various aspects of processing priority projects including interagency coordination and maintaining regular coordination with the national RECO.

Regular communication and coordination was conducted with BLM state and field office staff to exchange information the development of the Solar Programmatic EIS. State and field office staff provided much of the geographic information system data that allowed mapping of the BLM-administered lands and special status areas. The Programmatic EIS team held work sessions with each of the states to review exclusion criteria and design features, solicit input from state and field office staff and facilitate other information sharing. In addition, BLM state and field office staff were involved in reviews of preliminary, internal draft sections of text.

Coordination with BLM state and field office staff will continue throughout the preparation of the final Programmatic EIS to ensure that the analysis adequately reflects state- and local-level concerns and issues regarding solar energy development. In addition, BLM headquarters staff will work with state and field office staff following the release of the ROD to support its implementation of this Programmatic EIS and associated RMP amendments.

6.4 Agency Cooperation, Consultation, and Coordination

The BLM invited federal, Tribal, state, and local government agencies to participate in preparation of the Solar Programmatic EIS as cooperating agencies. A total of 77 agencies, listed below in Section 6.5, are currently working with the BLM as cooperating agencies; more cooperating agencies may participate in the future. The cooperating agencies include 38 counties. The BLM has held approximately biweekly briefings with cooperating agencies and solicited reviews of preliminary, internal draft analysis. The BLM will continue to engage with cooperating agencies throughout the preparation of the Programmatic EIS.

In accordance with the requirements of Section 106 of the NHPA, the BLM is coordinating with and soliciting input from the State Historic Preservation Offices (SHPOs) in each of the 11 states in the planning area and from the ACHP. On December 14, 2022, the BLM sent a letter informing each SHPO of the BLM's Notice of Intent to Prepare a Programmatic EIS to Evaluate Utility-Scale Solar Energy Planning and Amend Resource Management Plans for Renewable Energy Development. This also initiated consultation under Section 106 of the NHPA in connection with developing the Programmatic EIS to evaluate the environmental effects of utility-scale solar energy planning and amending RMPs.

The BLM had initially considered obtaining concurrence from the SHPOs by modifying the 2012 Solar PEIS Programmatic Agreement (Solar PA; ACHP 2012). However, the BLM now intends to conduct Section 106 consultation through the standard process identified in 36 CFR Part 800. As such, the BLM has requested concurrence from each SHPO with the BLM's finding pursuant to 36 CFR 800.4(d)(1) that this undertaking will have no effect on historic properties within the area of potential effect (APE). The APE includes public lands within Arizona, California (excluding the DRECP), Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

To support the BLM's formal Section 106 consultation request with each SHPO, the BLM has provided information for consideration and review which includes: (1) a description of the proposed undertaking; (2) consultation efforts; (3) identification of the APE; (4) efforts to identify historic properties within the APE; (5) analysis of the potential effects of the proposed RMP amendments on historic properties; and (6) BLM's finding.

In accordance with the requirements of Section 7 of the ESA, the BLM will consult with the U.S. Fish and Wildlife Service (USFWS) to ensure that the BLM's proposed action would not jeopardize the continued existence of any listed threatened or endangered species. Coordination regarding the consultation approach for the Programmatic EIS continues to occur. Under section 7(a)(1) of the ESA, BLM is also working with the USFWS to develop conservation measures for the Programmatic EIS that proactively conserve endangered species and threatened species.

In addition, the BLM has initiated activities to coordinate and consult with the governors in each of the 11 states and with state agencies (see Section 1.1.6). Additional coordination will be conducted during review of the draft Programmatic EIS. Prior to approval of the proposed plan amendments, the governor of each state will be given the opportunity to identify any inconsistencies between the proposed plan amendments and state or local plans and to provide recommendations in writing (during the 60-day consistency review period).

6.5 Cooperating Agencies

The BLM is the lead agency preparing this Programmatic EIS. Because the scope of the Programmatic EIS is of interest to numerous federal, state, Tribal, and local agencies, many expressed an interest in participating as cooperating agencies. The agencies listed in Table 1-3 are cooperating in the preparation of this Programmatic EIS as of September 2023; additional cooperating agencies may be added in the future.
The cooperating agencies were given the opportunity to review and comment on key portions of the Draft Programmatic EIS prior to release of the public draft; cooperating agency comments were considered and addressed to the extent appropriate and possible and will continue to be addressed through preparation of the Final Programmatic EIS.

Table 6-1. Cooperating Agencies for the Solar Programmatic EIS

State	Agencies
Arizona	• Arizona Game and Fish Department
California	• California Energy Commission
Colorado	• Baca County • Colorado Department of Natural Resources • Eagle County • Fremont County • Garfield County • Moffat County • Mesa County • Montezuma County • Montrose County • San Miguel County • Saguache County
Idaho	• Blaine County • Gooding County • Jerome County • Lincoln County • Office of Energy and Mineral Resources

State	Agencies
Montana	• Department of Natural Resources and Conservation • Grass Conservation Commission • Sweet Grass County Commissioners
Nevada	• Clark County • Department of Conservation and Natural Resources, Division of State Lands • Department of Agriculture • Department of Wildlife • Eureka County • Humboldt County • Lincoln County • Mineral County • Nevada Sagebrush Ecosystem Program • Nye County • White Pine County
New Mexico	• Energy, Minerals, and Energy Conservation Department, Energy Conservation and Management Division • Lincoln County • San Juan County • Upper Hondo Soil and Water Conservation District
Oregon	• Jefferson County • Lake County • Malheur County • Oregon Department of Fish and Wildlife
Utah	• Beaver County • Duchesne County • Dagget County • Iron County • Governor's Public Lands Policy Coordination Office • State of Utah School and Institutional Trust Lands Administration
Washington	• Washington Department of Ecology • Washington Department of Fish and Wildlife • Yakima County
Wyoming	• Campbell County Commissioners • Carbon County Commissioners • Converse County Commissioners • Converse County Conservation District • Hot Springs Conservation District • Lincoln Conservation District • Medicine Bow Conservation District • Park County Commissioners • Saratoga-Encampment-Rawlins Conservation District • Shoshone Conservation District • South Goshen County Conservation District • State of Wyoming Governor's Office • Sublette County Commissioners • Sublette County Conservation District • Sweetwater County Conservation District • Teton Conservation District • Washakie County Conservation District • Wyoming Department of Agriculture • Wyoming Department of Environmental Quality • Wyoming Game and Fish Department • Wyoming Oil and Gas Conservation Commission • Wyoming State Historic Preservation Office • Wyoming State Parks and Cultural Resources

State	Agencies
Federal	• DOD Military Aviation and Installation Assurance Siting Clearinghouse Office of the Assistant Secretary of Defense (Sustainment) • EPA • DOE Office of Energy Efficiency and Renewable Energy • DOI - NPS, Natural Resource Stewardship and Science • DOI - USFWS, Ecological Services

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