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Appendix A: Proposed BLM Land Use Plan Amendments Under the BLM Action Alternatives of the Solar Energy Development Programmatic Environmental Impact Statement

Analyses conducted in this Programmatic Environmental Impact Statement (EIS) support the proposed amendment of the U.S. Department of the Interior (DOI) Bureau of Land Management (BLM) land use plans in the 11-state planning area. The Programmatic EIS evaluates five different action alternatives. Under each of the action alternatives, the BLM proposes to amend land use plans within the 11-state planning area to adopt elements of the BLM's new program. The alternatives differ primarily with respect to which lands the agency would exclude from solar energy development and, therefore, which lands would be available for right-of-way (ROW) application.

Tables A-1 through A-10 provide information on the acreage associated with the proposed amendments for each existing land use plan under each of the alternatives for the states in the 11-state planning area.[1] Acreage for the No Action Alternative includes both lands identified as solar energy zones/renewable energy development areas (SEZs/REDAs) as well as variance areas in the 2012 Western Solar Plan, as amended.

Note that acreages included in these tables are representative of the mapped resources at the time of this analysis and that acreages of lands available for application may change with further plan amendments or updates to resource information.

[1] Land use plans for Oregon and Washington are presented in a single table as they are administered by the combined BLM Oregon and Washington State Office.

Table A-1. Proposed Lands Available for Application for Solar Energy Development in Arizona by Land Use Plan and Alternative

Land Use Plan Name	Land Use Plan Approval Year	Total BLM-Administered Acres in Planning Boundary	Lands Available for Application for Solar Energy Development (acres)[a]					
			No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Agua Fria NM RMP	2010	70,998	0	0	0	0	0	0
Arizona Strip RMP	2008	1,679,808	463,115	628,973	449,787	111,348	5,025	2,667
Bradshaw Harquahala RMP	2010	899,923	169,126	216,056	189,068	172,473	58,701	56,387
Grand Canyon-Parashant NM RMP	2008	809,368	0	0	0	0	0	0
Ironwood Forest NM RMP	2013	129,633	0	0	0	0	0	0
Kingman RMP	1995	2,336,487	538,930	1,335,465	694,618	498,471	204,565	162,170
Lake Havasu RMP	2007	1,312,009	457,192	753,968	510,685	376,966	147,542	122,205
Las Cienegas RMP	2003	51,317	0	0	0	0	0	0
Lower Gila North MFP	1983	140,181	56,235	81,801	64,421	25,166	913	913
Lower Sonoran RMP	2012	914,422	163,104	211,700	200,467	163,378	103,049	79,051
Phoenix RMP	1989	452,215	234,816	416,186	294,929	234,478	76,825	67,290
Safford RMP	1992/1994	1,399,234	601,408	1,117,349	627,131	505,035	228,261	182,934
San Pedro Riparian NCA RMP	2019	56,219	0	0	0	0	0	0
Sonoran Desert NM RMP	2012	486,512	0	0	0	0	0	0
Vermilion Cliffs NM RMP	2008	279,736	0	0	0	0	0	0
Yuma RMP	2010	1,230,267	177,598	121,395	117,674	110,114	39,108	32,317

[a] Lands available for application include priority areas (e.g., solar energy zones, renewable energy development areas), as amended since issuance of the Western Solar Plan. Under the No Action Alternative, both priority areas and variance areas are included.

Table A-2. Proposed Lands Available for Application for Solar Energy Development in California by Land Use Plan and Alternative

Land Use Plan Name	Land Use Plan Approval Year	Total BLM-Administered Acres in Planning Boundary	Lands Available for Application for Solar Energy Development (acres)[a]					
			No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Alturas RMP	2008	500,738	2,395	70,686	34,451	9,111	12,873	2,375
Arcata RMP	1992	134,391	3,383	25,094	969	581	536	536
Bakersfield RMP[a]	2014	409,345	10,063	158,912	25,616	22,343	25,027	22,159
Bishop RMP [a]	1993	751,993	40,126	150,443	62,998	61,321	26,363	26,057
California Coastal NM RMP	2005	6,306	0	0	0	0	0	0
California Desert Conservation Area Plan[a]	1980	10,613,742	0	0	0	0	0	0
Carrizo Plain NM RMP	2010	211,917	0	0	0	0	0	0
Clear Creek RMP	2014	82,788	1,234	33,815	92	0	0	0
Eagle Lake EIS	2008	1,011,668	3,127	71,591	36,933	7,235	10,570	3,281
Eastern San Diego County RMP[a]	2008	97,311	3,890	23,544	6,901	5,523	2,995	1,974
Headwaters Forest Reserve RMP	2004	7,531	0	0	0	0	0	0
King Range NCA RMP	2005	61,671	0	0	0	0	0	0
Redding RMP	1993	253,271	10,399	143,316	8,251	7,201	5,912	5,037
Santa Rosa and San Jacinto Mountains NM RMP[a]	2004	101,568	0	0	0	0	0	0
Sierra RMP	2007	230,425	8,900	182,931	6,856	6,762	3,261	3,172
South Coast RMP[a]	1994	137,187	7,976	66,307	4,066	2,082	2,519	1,377
Southern Diablo Mountain Range and Central Coast of California RMP	2007	288,533	12,795	155,283	910	784	508	506
Surprise RMP	2008	1,247,102	5,716	75,625	69,893	51,173	3,440	1,361
Ukiah RMP	2006	268,669	3,682	114,414	1,472	1,089	524	398

[a] Solar development applications for lands within the Desert Renewable Energy Conservation Plan (DRECP) boundary would remain subject to processing under the DRECP ROD; these areas are not included under total planning boundary or Alternative Lands Available. Because all priority areas in California fall within the DRECP boundary, no priority areas are included in Lands Available for Application.

Table A-3. Proposed Lands Available for Application for Solar Energy Development in Colorado by Land Use Plan and Alternative

Land Use Plan Name	Land Use Plan Approval Year	Total BLM-Administered Acres in Planning Boundary	Lands Available for Application for Solar Energy Development (acres)[a]					
			No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Browns Canyon NM RMP	2020	9,779	0	0	0	0	0	0
Canyons of the Ancients NM RMP	2010	172,986	0	0	0	0	0	0
Colorado River Valley RMP	2015	570,764	15,478	126,549	5,058	4,766	4,290	4,019
Colorado River Valley Roan Plateau RMP	2016	66,688	14,239	20,825	987	737	935	685
Dominguez-Escalante NCA RMP	2017	210,024	0	0	0	0	0	0
Grand Junction RMP	2015	1,059,214	1,276	56,385	24,811	13,062	12,319	10,527
Gunnison Gorge NCA RMP[b]	2004	96,137	215	519	287	287	271	271
Gunnison RMP	1993	659,366	1,538	47,580	11,312	2,846	1,360	1,360
Kremmling RMP	2015	377,627	1,163	92,542	22,722	19,694	6,660	6,311
Little Snake RMP	2011	1,338,113	1,277	372,970	123,948	80,562	28,659	18,234
McInnis Canyons NCA RMP	2004	123,456	0	0	0	0	0	0
Northeast RMP	1986	17,697	5,364	10,918	7,514	5,832	5,561	4,894
Royal Gorge RMP	1996	652,205	18,210	129,974	57,575	52,708	13,029	11,535
San Luis RMP	1991	499,638	78,026	203,792	110,576	34,198	61,898	29,569
Tres Rios RMP	2015	459,088	5,578	168,981	56,015	44,078	28,108	23,695
Uncompahgre RMP	2020	672,352	4,907	389,421	115,179	68,524	45,917	30,099
White River RMP	1997	1,450,280	1,978	666,189	131,188	114,396	61,408	49,004

[a] Lands available for application include priority areas (e.g., solar energy zones, solar emphasis areas), as amended since issuance of the Western Solar Plan. The Fourmile East SEZ was de-allocated in 2018 and the Los Mogotes SEZ is proposed for de-allocation through this Programmatic EIS; these areas are not included in the lands available for application. Under the No Action Alternative, both priority areas and variance areas are included.

[b] This plan includes lands both within and outside of the boundaries of the National Conservation Land unit identified. Therefore, while all lands identified within the unit are excluded from application under all action alternatives, certain lands managed in the land use plan but outside of the specially designated area may be identified as available for application.

Table A-4. Proposed Lands Available for Application for Solar Energy Development in Idaho by Land Use Plan and Alternative

Land Use Plan Name	Land Use Plan Approval Year	Total BLM-Administered Acres in Planning Boundary	Lands Available for Application for Solar Energy Development (acres)[a]					
			No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Bennett Hills Timmerman Hills MFP	1980	563,679	125,891	54,827	42,684	42,684	35,121	35,121
Big Desert MFP	1981	651,160	367,649	108,816	108,037	108,037	50,624	50,624
Big Lost MFP	1982	162,055	56,207	7,348	4,452	4,452	4,452	4,452
Bruneau MFP	1983	1,456,623	474,387	330,350	261,959	139,318	84,831	67,632
Cassia RMP	1985	466,609	445,227	235,263	166,635	166,593	127,968	127,926
Challis RMP	1999	791,758	432,272	25,085	569	546	485	462
Coeur d'Alene RMP	2007	99,793	79,116	63,026	395	318	363	286
Cottonwood RMP	2009	132,256	118,619	55,654	121	29	0	0
Craters of the Moon Monument RMP	2007	274,732	101,514	0	0	0	0	0
Four Rivers RMP	2023	783,808	751,365	213,476	98,370	89,753	84,001	75,768
Jarbidge RMP	2015	1,367,659	870,229	458,353	401,943	252,267	88,858	72,356
Lemhi RMP	1987	493,820	363,281	73,279	63	63	40	40
Little Lost and Birch Creek MFP	1985	341,944	109,999	1,617	434	184	348	184
Magic MFP	1980	27,262	333	0	0	0	0	0
Medicine Lodge RMP	1985	659,422	290,270	28,973	11,937	11,625	10,678	10,366
Monument RMP	1986	751,270	622,557	549,335	540,581	514,225	331,151	310,812
Morley Nelson Snake River Birds of Prey NCA RMP	2008	470,838	463,199	0	0	0	0	0
Owyhee RMP	1999	1,259,953	562,317	91,223	39,009	4,894	1,048	880
Pocatello RMP	2012	600,294	547,640	154,451	12,770	10,802	9,755	7,928
Sun Valley MFP	1981	241,718	141,053	81,220	395	372	187	163
Twin Falls MFP	1982	233,325	132,738	104,959	102,005	92,599	86,199	78,132

[a] Solar ROW applications in this state were not addressed under the Western Solar Plan. Under the No Action Alternative, lands available for application include all lands that are not otherwise excluded in existing land use plans.

Table A-5. Proposed Lands Available for Application for Solar Energy Development in Montana by Land Use Plan and Alternative

Land Use Plan Name	Land Use Plan Approval Year	Total BLM-Administered Acres in Planning Boundary	Lands Available for Application for Solar Energy Development (acres)[a]					
			No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Billings RMP	2015	433,964	149,991	3,689	2,298	1,583	1,467	775
Butte RMP	2009	308,193	270,358	90,916	7,741	5,996	5,855	4,237
Dillon RMP	2006	905,675	342,556	76,760	10,522	6,863	5,404	4,234
HiLine RMP	2015	2,438,082	920,633	676,369	524,927	127,827	411,138	100,736
Lewistown RMP	2021	654,986	415,065	164,377	34,809	2,050	13,293	1,301
Miles City RMP	2015	2,756,318	1,764,994	182,721	59,511	27,768	37,673	17,535
Missoula RMP	2021	175,672	148,629	23,033	1,064	760	370	324
Pompeys Pillar NM RMP	2015	58	0	0	0	0	0	0
Upper Missouri River Breaks NM RMP	2008	374,617	0	0	0	0	0	0

[a] Solar ROW applications in this state were not addressed under the Western Solar Plan. Under the No Action Alternative, lands available for application include all lands that are not otherwise excluded in existing land use plans.

Table A-6. Proposed Lands Available for Application for Solar Energy Development in Nevada by Land Use Plan and Alternative

Land Use Plan Name	Land Use Plan Approval Year	Total BLM-Administered Acres in Planning Boundary	Lands Available for Application for Solar Energy Development (acres)[a]					
			No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Black Rock Desert-High Rock Canyon NCA RMP	2004	1,205,395	0	0	0	0	0	0
Carson City RMP	2001	4,775,177	924,498	3,394,896	1,666,112	1,078,700	376,594	268,354
Elko RMP	1987	3,190,716	1,327	149,537	124,119	67,499	14,795	13,719
Ely RMP	2008	11,416,457	1,834,465	3,748,817	2,276,610	1,139,280	260,548	122,342
Las Vegas RMP	1998	3,080,784	791,363	1,193,749	847,026	805,140	284,718	270,104
Nevada Test and Training Range RMP	2004	1,136	1,134	1,135	812	780	33	33
Red Rock Canyon NCA RMP	2005	196,126	0	0	0	0	0	0
Shoshone-Eureka RMP	1986	4,383,120	275,877	1,105,556	670,155	325,534	147,226	94,067
Sloan Canyon NCA RMP	2006	48,445	0	0	0	0	0	0
Tonopah RMP	1997	6,070,058	2,901,464	4,697,968	3,423,851	1,753,293	541,457	309,298
Wells RMP	1985	4,252,530	2,264	1,184,671	682,410	100,833	98,632	19,844
Winnemucca RMP	2015	7,226,338	95,772	2,704,115	2,139,437	1,393,523	645,867	452,226

[a] Lands available for application include priority areas (e.g., solar energy zones, the Dry Lake East Designated Leasing Area), as amended since issuance of the Western Solar Plan. Under the No Action Alternative, both priority areas and variance areas are included.

Table A-7. Proposed Lands Available for Application for Solar Energy Development in New Mexico by Land Use Plan and Alternative

Land Use Plan Name	Land Use Plan Approval Year	Total BLM-Administered Acres in Planning Boundary	Lands Available for Application for Solar Energy Development (acres)[a]					
			No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Carlsbad RMP	1988	2,091,155	282,505	1,102,262	963,862	636,671	703,424	530,413
El Malpais NCA RMP	2001	229,530	109	0	0	0	0	0
Farmington RMP	2003	1,423,392	389,799	449,243	267,334	219,471	237,465	195,261
Kasha-Katuwe Tent Rocks NM RMP	2007	4,629	0	0	0	0	0	0
Mimbres RMP	1993	3,069,771	1,158,321	1,465,570	1,227,277	874,951	322,379	213,830
Prehistoric Trackways NM RMP	2015	5,262	0	0	0	0	0	0
Rio Puerco RMP	1986	758,564	301,852	434,844	313,144	214,789	59,054	55,016
Roswell RMP	1997	1,476,840	767,250	1,076,697	943,565	355,646	271,147	187,708
Socorro RMP	2010	1,508,686	576,012	878,712	655,433	306,369	65,231	39,274
Taos RMP	2012	597,992	17,225	52,769	21,901	5,792	9,317	1,155
White Sands RMP	1986	2,308,531	422,496	830,752	457,142	291,893	55,549	49,474

[a] Lands available for application include priority areas (i.e., the Afton solar energy zone), as amended since issuance of the Western Solar Plan. Under the No Action Alternative, both priority areas and variance areas are included.

Table A-8. Proposed Lands Available for Application for Solar Energy Development in Oregon and Washington by Land Use Plan and Alternative

Land Use Plan Name	Land Use Plan Approval Year	Total BLM-Administered Acres in Planning Boundary	Lands Available for Application for Solar Energy Development (acres)[a]					
			No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Andrews RMP	2005	1,217,285	613,550	17,256	15,302	11,215	7,414	6,488
Baker RMP	1989	426,264	270,551	168,646	9,366	9,000	4,805	4,554
Brothers La Pine RMP	1989	707,765	318,416	81,804	38,980	17,186	7,527	3,669
Cascade-Siskiyou NM RMP	2008	65,457	36,131	0	0	0	0	0
John Day Basin RMP	2015	466,221	350,797	38,572	7,891	1,997	3,660	1,123
Lakeview RMP	2003	3,203,485	2,110,164	524,766	444,674	327,404	153,923	114,792
Northwestern and Coastal Oregon RMP	2016	1,253,331	1,219,986	458,039	9,932	9,737	7,845	7,650
San Juan Islands NM RMP	2023	713	0	0	0	0	0	0
Southeastern Oregon RMP	2002	4,641,890	2,741,333	475,419	288,491	123,255	78,465	52,821
Southwestern Oregon RMP	2016	1,208,203	1,144,023	487,037	87,124	49,324	32,984	30,824
Spokane District RMP	1987	420,148	397,052	352,117	109,585	92,371	81,871	69,177
Steens Mountain Cooperative Management and Protection Area RMP	2005	428,615	138,181	0	0	0	0	0
Three Rivers RMP	1992	1,618,400	1,612,847	185,614	126,228	82,690	53,662	34,413
Two Rivers RMP	1986	88,131	70,770	68,174	10,309	8,320	3,291	3,015
Upper Deschutes RMP	2005	402,770	348,255	7,958	2,622	2,621	1,619	1,619
Upper Klamath Basin and Wood River Wetland RMP	1996	3,176	3,176	0	0	0	0	0
West Eugene Wetlands RMP	2015	1,337	162	185	185	185	185	185

[a] Solar ROW applications in this state were not addressed under the Western Solar Plan. Under the No Action Alternative. lands available for application include all lands that are not otherwise excluded in existing land use plans.

Table A-9. Proposed Lands Available for Application for Solar Energy Development in Utah by Land Use Plan and Alternative

Land Use Plan Name	Land Use Plan Approval Year	Total BLM-Administered Acres in Planning Boundary	Lands Available for Application for Solar Energy Development (acres)[a]					
			No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Bears Ears NM - RMPs for the Indian Creek and Shash Jaa Units	2020	169,391	0	0	0	0	0	0
Beaver Dam Wash NCA RMP	2016	63,585	0	0	0	0	0	0
Box Elder RMP	1986	1,077,412	12,189	610,533	537,130	70,759	37,195	19,303
Cedar Beaver Garfield Antimony RMP	1986	893,620	150,343	464,228	254,989	251,041	184,925	181,668
Grand Staircase-Escalante NM RMP	2020	1,004,450	0	0	0	0	0	0
House Range RMP	1987	2,189,470	230,734	1,465,698	1,122,294	330,766	184,327	96,071
Isolated Tract Planning Analysis	1985	1,843	283	1,439	29	0	0	0
Kanab RMP	2008	553,793	17,958	96,756	37,904	19,243	12,267	9,431
Kanab-Escalante RMP	2020	862,632	0	0	0	0	0	0
Moab RMP	2008	1,837,678	3,324	363,975	175,547	40,700	57,454	27,114
Monticello RMP	2008	1,616,895	10,806	79,607	28,937	27,919	20,650	20,440
Park City MFP	1975	1,689	167	1,359	0	0	0	0
Pinyon MFP	1983	1,199,629	444,815	1,057,696	572,833	440,128	187,398	166,664
Pony Express RMP	1990	2,031,885	63,180	1,481,771	1,068,529	535,452	219,006	131,586
Price RMP	2008	2,480,406	5,949	656,866	376,944	367,213	192,378	190,547
Randolph MFP	1980	171,561	10	3,483	243	0	243	0
Red Cliffs NCA RMP	2016	45,400	0	0	0	0	0	0
Richfield RMP	2008	2,126,925	67,171	606,048	222,109	130,548	70,546	66,803
St. George RMP	1999	520,062	8,955	181,865	34,095	26,556	9,913	5,971
Vernal RMP	2008	1,688,340	706	833,594	341,418	271,796	234,184	206,875
Warm Springs RMP	1987	2,230,667	798,955	1,969,243	1,537,326	1,089,915	440,838	376,146

[a] Lands available for application include priority areas (e.g., solar energy zones), as amended since issuance of the Western Solar Plan. Under the No Action Alternative, both priority areas and variance areas are included.

Table A-10. Proposed Lands Available for Application for Solar Energy Development in Wyoming by Land Use Plan and Alternative

Land Use Plan Name	Land Use Plan Approval Year	Total BLM-Administered Acres in Planning Boundary	Lands Available for Application for Solar Energy Development (acres)[a]					
			No Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Buffalo RMP	2015	920,095	700,308	306,263	97,616	66,884	64,743	45,606
Casper RMP	2007	1,546,900	740,963	524,643	318,597	271,693	156,081	151,136
Cody RMP	2015	1,086,618	738,347	313,733	240,044	117,457	114,325	56,266
Green River RMP	1997	3,606,761	1,694,310	1,083,733	817,257	414,627	267,116	169,562
Kemmerer RMP	2010	1,421,087	734,836	586,318	427,944	380,119	295,153	282,210
Lander RMP	2014	2,388,614	618,858	408,151	319,218	311,948	124,133	122,220
Newcastle RMP	2000	515,981	284,617	243,940	175,389	84,870	92,857	53,125
Pinedale RMP	2008	923,236	474,690	163,910	137,842	131,411	75,144	71,590
Rawlins RMP	2008	3,531,896	1,941,262	1,476,546	1,203,536	991,932	422,501	387,931
Snake River RMP	2004	969	969	0	0	0	0	0
Worland RMP	2015	2,099,390	1,208,742	282,217	193,976	77,044	69,491	32,610

[a] Solar ROW applications in this state were not addressed under the Western Solar Plan. Under the No Action Alternative, lands available for application include all lands that are not otherwise excluded in existing land use plans.

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Appendix B: Proposed Programmatic Design Features Under the BLM Action Alternatives

The BLM has identified a set of proposed programmatic design features that would be required for all future utility-scale PV solar energy projects on BLM-administered lands in the 11-state planning area under any of the action alternatives. Design features are project requirements that have been incorporated into the alternatives to avoid, minimize, or compensate for adverse impacts. Design features provide mitigation for project impacts as defined under CEQ regulations at 40 CFR 1508.1.[1] The proposed design features presented in this section would update the design features established through the Western Solar Plan that are currently in effect. When a ROD is completed for this Solar Programmatic EIS, applicants seeking approvals to construct, operate, and decommission utility-scale solar energy projects on BLM-administered lands will be required to implement the final updated design features to avoid, minimize, and/or mitigate the impacts associated with their projects.

The proposed programmatic design features in this section address the broad possible range of direct and indirect impacts that may result from utility-scale PV solar energy development on BLM-administered lands, as described in Chapter 5 of this Draft Solar Programmatic EIS. The impacts evaluated include those from the solar facilities themselves as well as associated infrastructure such as transmission facilities and roads. While the programmatic design features that follow address utility-scale solar energy projects comprehensively, the land use plan decisions to be made through the Solar PEIS ROD (e.g., exclusions and lands available for application) will only be applicable 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 proposed programmatic design features in this appendix were identified through comprehensive reviews of PV solar energy development activities (as described in Chapter 3); review of published literature and data regarding solar energy development mitigation measures; existing, relevant mitigation guidance; and BLM experience to date in permitting and monitoring PV solar energy facilities. However, the applicability and overall effectiveness of each design feature cannot be fully assessed until the project level, when the project location and design are known. Because of site-specific circumstances, some design features may not apply to some projects (e.g., a resource is not present on a given site) and/or may require slight variations (e.g., a larger or smaller protective area). Design features are continuously improving as new science and technology become available and therefore are subject to change. All variations in

[1] The CEQ regulations define mitigation as actions that address project impacts by: 1) avoiding impacts by not taking a certain action or parts of an action, 2) minimizing impacts by limiting the degree or magnitude of the action and its implementation, 3) rectifying impacts by repairing, rehabilitating, or restoring the affected environment, 4) reducing or eliminating impacts over time by preservation and maintenance operations during the life of the action, and 5) compensating for impacts by replacing or providing substitute resources or environments. All five aspects of mitigation can, as a practical matter, be summarized as avoidance, minimization, and compensation.

design features would require that at least one of the following be demonstrated in the NEPA analysis associated with the project/activity:

- A specific design feature is documented to not be applicable to the site-specific conditions of the project/activity (e.g., due to site limitations or engineering considerations). Economic considerations, such as increased costs, do not necessarily require that a design feature be varied or rendered inapplicable.
- An alternative design feature, a state-implemented conservation measure, or plan-level protection is determined to provide equal or better protection for ecological resources.
- A specific design feature will provide no additional protection to ecological resources, considering application of other design features.

Applicants will be required to work with the BLM to address proposed variations in the design features and to discuss selected options for avoidance, minimization, and/or mitigation of potential resource conflicts. Variations in programmatic design features will require appropriate analysis and disclosure as part of individual project authorizations. Programmatic design features that do not apply to a given project should be described as part of the project case file along with an appropriate rationale. Additional mitigation measures may be identified and required during individual project development and environmental review.

The proposed programmatic design features would apply to all utility-scale PV solar energy projects on BLM-administered lands, whether those projects are within lands available for application or priority areas such as solar energy zones, solar renewable energy development areas in Arizona, or solar emphasis areas. Based on the extensive upfront data collection and environmental analysis that has been completed for these priority areas, the BLM expects that many of the requirements associated with programmatic design features will be met or substantially met for lands within these areas.

The proposed programmatic design features are not intended to be duplicative of other federal, state, and/or local requirements. In the early stages of siting and design, project developers shall coordinate with appropriate federal, state, and local agencies to determine what plans, permits, and/or approvals may be needed. Where possible, project developers should seek to consolidate such requirements in coordination with the BLM. In addition, the requirements of individual programmatic design features may be consolidated to further avoid duplication. The proposed programmatic design features are also not intended to be unduly burdensome to the applicant. For example, applicants will not be expected to study resources or collect data beyond what is necessary to disclose and provide knowledge of reasonable avoidance, minimization, and/or mitigation of impacts from a proposed project.

The BLM will require that the activities specified through the proposed programmatic design features be identified and disclosed as part of the project's Plan of Development (POD) to be submitted to the BLM with a right-of-way (ROW) application for solar energy development on public lands. In situations where similar activities are required to meet

other federal, state, and/or local permitting requirements, the BLM encourages developers to address these duplicative requirements in separate submittals and append the information to their POD. Examples of such information that may be required for a separate permitting action and appended to the POD include a Stormwater Pollution Prevention Plan, Dust Abatement Plan, and Decommissioning and Site Reclamation Plan (see Table B-1).

Table B-1. Individual Plans Specified as Elements of the Proposed Programmatic Design Features

Plan Name	Applicable Design Features[a]
Bird and Bat Conservation Strategy (includes Nesting Bird Management Plan)	ER-G-13w
Decommissioning and Site Reclamation Plan	ER-C-5dt; ER-D-1g, 4g, 1v, 3v; HMW-G-4
Dust Abatement Plan	AQC-C-2, ER-G-3g, VR-O-4
Hazardous Materials and Waste Management Plan	HMW-G-4
Health and Safety Plan	HS-G-3
Lighting Plan	VR-C-3al
Spill Prevention and Emergency Response Plan	ER-G-12g; HMW-G-4,12; WR-C-4
Stormwater Pollution Prevention Plan	ERG-G-1aq, GS-C-1, WR-G-1ro
Threatened and endangered species protection plan	ER-G-1sss, 3sss, 7sss; ER-C-17dt
Transportation Plan	T-G-2
Traffic Management Plan	T-G-2
Vegetation/Weed Management Plan	ER-C-11v, WF-C-5, WF-O-1
Worker Education and Awareness Plan (WEAP)	CR-G-4; CR-D-1; ER-G-19g, 4w, 7w, 6sss; LR-G-9; P-G-3,6; WHB-G-5; WF-G-5

[a] The design features specifying the need for individual plans are listed in Sections B.1 through B.21.

The design features are presented by resource type and by four project phases as applicable (i.e., [1] general; [2] site characterization, siting and design, and construction; [3] operations and maintenance; and [4] decommissioning/reclamation). Updates have been made to the 2012 Western Solar Plan design features to reflect broader knowledge about effective mitigation of impacts from solar energy development based on ten years of BLM experience with permitting and monitoring solar energy facilities. Two additional important general updates have been made to made the design features clearer:

- All design features are required if applicable within the location of the solar energy facility. Items that are not appropriate for designating as required (e.g., items not within the jurisdiction of the BLM) have been moved to the resource-specific mitigation measure sections of Chapter 5. Although these mitigation measures are not required as programmatic design features, they are included in Chapter 5 for consideration by project developers and the BLM during the project-specific evaluations.

- Each design feature now includes designation of the party responsible for implementation of that design feature. While usually this is the project developer or operator, in some cases it is the BLM.

Each design feature is numbered to aid in tracking status of completion through each phase of a solar development project. The numbering system consists of a one-or two-letter prefix code for the resource, one letter denoting the applicable phase of development (G – general; C – site characterization, siting and design, and construction; O – operations and maintenance; and D – decommissioning/reclamation), and then consecutive numbering for design features for that resource and phase of development (for example, N-G-1 is the first design feature for Acoustic Environment [Noise] in the general category). For three resources there are additional categorizations. The Ecological Resource design features are further characterized as applicable for mitigating impacts on general habitat (g); vegetation (v), aquatic biota (aq), wildlife (w), and special status species (sss). So design features for vegetation each includes a "v" suffix denoting the type of ecological resource for which it is most applicable. For example, ER-O-10v indicates the tenth design feature to mitigate for adverse impacts to ecological resources during operations, most applicable for mitigating for impacts on vegetation. Visual Resource and Water Resource design features also include additional categorizations.

B.1 Design Features for Acoustic Environment (Noise, N)

The following design features have been identified to avoid, minimize, and/or mitigate potential impacts on the acoustic environment from utility-scale solar energy development on BLM-administered lands.

B.1.1 General

Project developers shall consult with the BLM in the early phases of project planning to assess and minimize the proposed project's noise impacts on sensitive noise receptors. Consultation with the BLM shall be maintained through operations and maintenance of the project, employing an adaptive management strategy and modifications as necessary and approved by the BLM. The following requirements must also be met.

- **N-G-1** Project developers shall take measurements to assess the existing background ambient sound levels both within and outside the project site and compare these with the anticipated noise levels at the facility. The ambient measurement protocols of all affected land management agencies shall be considered and utilized. Nearby residences and likely sensitive human and wildlife receptor locations shall be identified.
- **N-G-2** Project developers shall conduct assessments for noise impacts by employing qualified individuals and using appropriate and commonly accepted software, procedures, and past project examples.

- **N-G-3** Project developers shall evaluate impacts from noise as part of the environmental impact analysis for the project and consider options to avoid, minimize, and/or mitigate adverse impacts in coordination with the BLM.
- **N-G-4** Project developers shall require that vehicles traveling within and around the project area keep within posted speed limits to reduce vehicle noise levels.

B.1.2 Site Characterization, Siting and Design, Construction

- **N-C-1** Project developers shall enclose noisy equipment when located near sensitive human or wildlife receptors.
- **N-C-2** Project developers shall post warning signs at high-noise areas and implementing a hearing protection program for work areas with noise in excess of 85 dBA.
- **N-C-3** Project developers shall implement a noise complaint process and hotline, including documentation, investigation, evaluation, and resolution of legitimate project-related noise complaints.
- **N-C-4** Project developers shall maintain project equipment in accordance with manufacturers' specifications. For example, suitable mufflers and/or air-inlet silencers shall be installed on all internal combustion engines (ICEs) and certain compressor components.
- **N-C-5** Project developers shall limit low-altitude (under 1,500 ft [457 m]) helicopter flights for installation of transmission lines near noise-sensitive human and wildlife receptors to locations where only helicopter activities can perform the installation.
- **N-C-6** Project developers shall schedule construction activities to minimize disruption to nearby residents and existing operations surrounding the project areas.
- **N-C-7** Project developers shall plan noisy construction activities near sensitive receptors to take place during the least noise-sensitive times of day (i.e., daytime between 7 a.m. and 7 p.m.), and on weekdays. For wildlife, noise-sensitive times shall consider breeding, nesting, and wintering.
- **N-C-8** Project developers shall coordinate individual noisy activities to occur at the same time to reduce the frequency of site boundary noise.
- **N-C-9** Project developers shall implement noise control measures (e.g., erection of temporary wooden noise barriers, mufflers) where activities are expected near sensitive human or wildlife receptors.
- **N-C-10** Project developers shall notify nearby residents in advance of noisy activities, such as blasting or pile driving, before and during the construction period.
- **N-C-11** Project developers shall site permanent sound-generating facilities (e.g., compressors, pumps, generators) away from residences and other

sensitive human or wildlife receptors. The use of acoustic screening may be required.

- **N-C-12** Project developers shall incorporate low-noise systems (e.g., for ventilation systems, pumps, generators, compressors, and fans) and select equipment without prominent discrete tones.
- **N-C-13** Project developers shall include noise reduction measures such as siting noise sources to take advantage of existing topography and distances and constructing engineered sound barriers and/or berms or sound-insulated buildings to reduce potential noise impacts at the locations of nearby sensitive receptors.
- **N-C-14** Project developers shall incorporate environmental inspection and monitoring measures into PODs or other relevant plans to monitor and respond to impacts from noise during construction, operations, and decommissioning of a solar energy facility, including adaptive management protocols.

B.1.3 Operations and Maintenance

- **N-O-1** Project operators shall schedule activities to minimize disruption to nearby residents and existing operations surrounding the project areas, and to minimize disruption to sensitive wildlife receptors especially during breeding, nesting, and wintering periods.
- **N-O-2** Project operators shall monitor and maintain transformer noise levels, and consider installation of new transformers with reduced flux density, which generate noise levels as much as 10 to 20 dB lower than National Electrical Manufacturers Association (NEMA) standard values, or use of barrier walls, partial enclosures, or full enclosures to shield or contain the noise.

B.1.4 Decommissioning/Reclamation

- **N-D-1** Project operators shall notify nearby residents in advance of noisy activities, such as blasting, before and during the decommissioning and reclamation activities, if any.
- **N-D-2** Project operators shall reclaim the site by incorporating the design features listed above for construction to reduce the likelihood of noise impacts from decommissioning.

B.2 Design Features for Air Quality and Climate (AQC)

The following design features have been identified to avoid, minimize, and/or mitigate potential impacts on ambient air quality and climate from utility-scale solar energy development on BLM-administered lands.

B.2.1 General

Project developers shall consult with the BLM in the early phases of project planning to help determine the potential conformance to air quality (National Ambient Air Quality Standards; NAAQS) and other potential constraints. Project developers shall continue to consult with the BLM to minimize air quality and climate impacts throughout project construction, operation, and decommissions/reclamation, employing an adaptive management strategies and modifications.

- **AQC-G-1** Project developers shall identify air quality and other related constraints associated with the proposed project site. In coordination with BLM, the appropriate air regulatory authorities shall be consulted to identify air quality and related constraints and requirements.
- **AQC-G-2** Project developers shall identify all applicable federal, state, Tribal, and local laws and regulations related to air quality.
- **AQC-G-3** Project developers shall consider effects on particulate matter PM_{10} and $PM_{2.5}$ from the solar energy project and its facilities.
- **AQC-G-4** Project developers shall evaluate the cumulative impacts to air quality and air quality related values in Prevention of Significant Deterioration (PSD) Class I areas.
- **AQC-G-5** Project developers shall evaluate potential contributions to air quality impacts as part of the environmental impact analysis for the project and considering options to avoid, minimize and/or mitigate adverse impacts in coordination with the BLM.
- **AQC-G-6** Project developers shall reduce commuter vehicle trips through car pools, commuter vans or buses, innovative work schedules or work camps.

B.2.2 Site Characterization, Siting and Design, Construction

- **AQC-C-1** Project developers shall use equipment that meets emission standards specified in the state code of regulations and meets the applicable EPA Tier 3 (on a case-by-case basis if use of Tier-4 engine is infeasible) and Tier 4 (highly recommended) emissions requirements. Project developers shall prioritize use of electric drive equipment, as available, and reformulated diesel for all diesel engines.
- **AQC-C-2** Project developers shall prepare a Dust Abatement Plan for the solar facilities that considers multiple methods for dust suppression (i.e., water, paving, clean gravel, and/or regulation-compliant palliatives).
- **AQC-C-3** Project developers shall manage unpaved roads, disturbed areas (e.g., areas of scraping, excavation, backfilling, grading, and compacting), and loose materials generated during project activities as frequently as necessary to effectively minimize fugitive dust generation by maintaining site soils in a moist or crusted condition.

- **AQC-C-4** Project developers shall limit travel to stabilized roads.
- **AQC-C-5** Project developers shall require vehicles that transport loose materials to be covered as they travel on public roads, use dust suppressants on truck loads, and keeping loads below the freeboard of the truck bed.
- **AQC-C-6** Project developers shall install wind fences around disturbed areas that could affect the area beyond the site boundaries (e.g., nearby residences).
- **AQC-C-7** Project developers shall suspend soil disturbing activities and travel on unpaved roads during periods of high winds. Site-specific wind speed thresholds shall be determined on the basis of soil properties determined during site characterization.
- **AQC-C-8** Project developers shall require the use of real-time onsite dust monitors to document and be able to respond in a timely fashion, to wind/emission events. Monitors shall remain installed for the lifespan of the project. Simple ways to monitor and summarize the data should be used. Experts shall be employed to analyze the data. Real-time data shall be accessible to the public and presented in a helpful context (e.g., compared with public health standards).
- **AQC-C-9** Project developers shall avoid construction activities under low wind and stable atmospheric conditions (i.e., temperature inversions), which would frequently occur around sunrise in colder months and cause high 24-hr PM concentrations.
- **AQC-C-10** Project developers shall limit the idling time of off-road engines and equipment to no more than 2 minutes, unless idling must be maintained for proper operation (e.g., drilling, hoisting, and trenching).
- **AQC-C-11** Project developers shall avoid use of chemical dust suppressants that emit volatile organic compounds within or near ozone nonattainment areas, to the extent practicable.
- **AQC-C-12** Project developers shall minimize use of dust palliatives in areas of close proximity to sensitive soil and streams.
- **AQC-C-13** Project developers shall access transmission lines from public roads and designated routes to minimize fugitive dust emissions.
- **AQC-C-14** Project developers shall minimize onsite vehicle use and require routine preventive maintenance, including tune-ups to meet the manufacturer's specifications, to ensure efficient combustion and minimal emissions.
- **AQC-C-15** Project developers shall limit access to the construction site and staging areas to authorized vehicles only through the designated treated roads.
- **AQC-C-16** Project developers shall stage construction to limit the areas exposed at any time, and stabilize areas that are not actively being disturbed.
- **AQC-C-17** Project developers shall require inspection and cleaning of tires of all construction-related vehicles to ensure they are free of dirt before they enter paved public roadways.

- **AQC-C-18** Project developers shall clean up visible trackout or runoff dirt on public roadways resulting from the construction site (e.g., a gravel apron, pipe-grid trackout-control device, or street vacuum/sweeping).
- **AQC-C-19** Project developers shall salvage topsoil from all excavations and construction and reapply to construction areas not needed for facility operation as soon as activities in that area have ceased.
- **AQC-C-20** Project developers shall consider atmospheric conditions when planning construction activities to minimize dust.
- **AQC-C-21** Project developers shall avoid ground disturbance from construction-related activities in areas with intact biological soil crusts and desert pavement and leave vegetation root systems in place to the greatest extent practicable. When removed, developers shall salvage soil crusts for restoration, once construction has been completed.
- **AQC-C-22** Project developers shall incorporate environmental inspection and monitoring measures into the POD and other relevant plans to monitor and respond to potential air quality issues during construction, operations, and decommissioning of a solar energy development, including adaptive management protocols.

B.2.3 Operations and Maintenance

- **AQC-O-1** Project operators shall continue to monitor and treat (e.g., by applying dust suppressants), as needed, areas that have been graded, scraped, bladed, compacted, or denuded of vegetation.
- **AQC-O-2** Project operators shall lay down gravel, compact native soil, or reapply palliatives or water as necessary for effective fugitive dust management.
- **AQC-O-3** Project operators shall ensure compliance of all combustion sources with state emission standards (e.g., best available control technology requirements).

B.2.4 Decommissioning/Reclamation

- **AQC-D-1** Project operators shall reclaim the site by incorporating the design features listed above for construction to reduce the likelihood of air quality impacts from decommissioning.

B.3 Design Features for Cultural Resources (CR)

The following design features have been identified to avoid, minimize, and/or mitigate potential impacts on cultural resources from utility-scale solar energy development on BLM-administered lands.

B.3.1 General

Project developers shall coordinate with the BLM early in the planning process, and the BLM shall consult with other Federal, Tribal, state, and local agencies as appropriate, to identify and minimize cultural resource impacts by:

- **CR-G-1** The BLM shall initiate Section 106 consultations between the BLM, SHPOs, Indian Tribes (including the Tribal Historic Preservation Office (THPO) where applicable), and other consulting parties early in the project planning process. Thresholds for the involvement of and review by the Advisory Council on Historic Preservation (ACHP) include non-routine interstate and/or interagency projects or programs; undertakings adversely affecting National Historic Landmarks; undertakings that the BLM determines to be highly controversial; and undertakings that will have an adverse effect on historic properties and with respect to which disputes cannot be resolved through formal agreement between the BLM and SHPO/THPO, such as a Memorandum of Agreement (MOA).
- **CR-G-2** The BLM shall conduct site-specific Section 106 review for individual projects, and shall require the completion of a cultural resource inventory, evaluation, findings of effect, and resolution of adverse effects in accordance with the nPA or the Solar PA, if applicable. The Solar PA does not apply to the five states that have been added.

For projects where cultural resource areas of concern have been identified through the general design features listed above, impacts would be minimized by:

- **CR-G-3** Project developers shall develop plans to minimize impacts on lands within or adjacent to historic properties, sites with Tribal interests, or contain high potential for NRHP-eligible properties. If historic properties that could be adversely affected are present in the project location and cannot be avoided or impacts minimized, an MOA (tiered to the Solar PA if applicable) to address the steps that shall be followed to avoid, minimize, or otherwise resolve adverse effects on historic properties may be developed. Project developers shall be notified that resource assessment, inventorying, and mitigation costs may be high in such areas. All cultural plans of operation and/or MOAs shall be developed in consultation with BLM Field Offices and must be approved before project development proceeds. All project plans shall be distributed to BLM field offices, district or State archaeologists, and the THPO (where applicable) for review.
- **CR-G-4** Project developers shall use training/educational programs for workers to minimize occurrences of disturbances, vandalism, and harm to nearby historic properties. The specifics of these sensitivity training programs shall be established in project-specific consultations between the applicant, BLM, SHPO/THPO, and affected Indian Tribes, and shall be articulated in a WEAP. Such education and awareness plans shall incorporate adaptive management protocols for addressing changes over the life of the project, should they occur.

- **CR-G-5** Project developers shall secure a performance and reclamation bond for all solar energy generation facilities to ensure compliance with the terms and conditions of the ROW authorization. When establishing bond amounts and conditions, the BLM authorized officer shall require coverage of all expenses tied to cultural resources identification, protection, and mitigation. These may include, but are not limited to, costs for ethnographic studies, inventory, testing, geomorphological studies, data recovery, curation (including NAGPRA and museum collection costs), monitoring, treatment of damaged sites, and generation and submission of reports (see BLM IM-2019-013, available at https://www.blm.gov/policy/im-2019-013, as cited in Chapter 3, Section 3.3.1).

B.3.2 Site Characterization, Siting and Design, Construction

Project developers and the BLM shall characterize, site and design, and construct solar energy facilities in coordination with the BLM to minimize cultural resource impacts.

- **CR-C-1** The BLM shall determine the APE for each proposed solar energy project, to include a review of existing information, and efforts to seek information from and views of Tribes and other parties likely to have knowledge of or concerns with historic properties in the APE. This information shall be supplemented by discussions at pre-application meetings with the solar energy project applicant, SHPO/THPO, and affected Tribes regarding project designs, sacred sites, traditional cultural properties (TCPs), and proposed cultural resource inventory strategies. The APEs shall not be finalized until after consultation with the SHPO/THPO and Tribes occurs.
- **CR-C-2** Project developers shall undertake a Class III inventory of the proposed project ground disturbance footprint and buffer. If the BLM decides to require less than a Class III inventory for the entire project area, the BLM shall seek additional views of the SHPO/THPO, affected Tribes, and other parties and determine the final inventory strategy that best represents a reasonable and good-faith effort to carry out appropriate identification efforts.
- **CR-C-3** Project developers shall conduct inventories according to the standards set forth in the Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation (48 FR 44716); BLM Handbook H-8110 (Handbook for Identifying Cultural Resources); revised BLM Manual 8110; applicable BLM or SHPO/THPO survey, site record, or reporting standards, and any other applicable state, Tribal, local laws, standards, and guidelines. All inventory data must be provided to the BLM in digitized or paper format that meets BLM data standards, including shape files for surveyed areas.
- **CR-C-4** The BLM shall consult with the SHPO/THPO, affected Tribes (regarding the treatment of adverse effects for those property types on which the Tribes indicate at pre-application or other meetings they wish to provide input), and any other consulting parties, if *National Register of Historic Places* (NRHP)-eligible or listed properties are present at the site and would be adversely affected. The BLM shall seek agreement to avoid, minimize, or mitigate adverse effects on

historic properties. If considered necessary by the parties, the BLM shall execute an MOA with the SHPO/THPO to conclude the Section 106 process and will file a copy with the ACHP. Where the BLM and the SHPO/THPO are unable to execute an MOA but feel one is necessary, the BLM shall invite the ACHP to participate in an undertaking-specific MOA. The MOA shall specify the treatment for which the BLM shall be responsible, and which shall be implemented by the solar applicant.

- **CR-C-5** Project developers shall bring any post-review, unexpected discovery of cultural resources encountered during any phase of development (construction, operations and maintenance, or decommissioning) to the attention of the responsible BLM authorized officer immediately. Work shall be halted in the vicinity of the discovery. The area of the discovery shall be protected to ensure that the resources are not removed, handled, altered, or damaged while they are being evaluated and to ensure that appropriate mitigative or protective measures can be developed and implemented.

  In situations where historic properties require management or monitoring for avoidance and protection within or near a project's boundaries, measures shall specify the preparation and implementation of steps to lessen the adverse effects of the undertaking upon those aspects of NRHP eligibility criteria that make the historic properties eligible for nomination to the NRHP.
- **CR-C-6** Project developers shall restrict or prohibit surface, auditory, and atmospheric disturbance near or on such property types when their eligibility is tied to their visual and/or auditory setting as well as aspect of integrity related to feeling and association. This measure shall be implemented to protect NRHP-eligible traditional cultural properties, sacred sites, or historic trails from visual or auditory intrusion and to maintain the integrity of their historic setting unless acceptable resolution of adverse effects is proposed.
- **CR-C-7** The project developer shall employ archaeological field monitors and/or Tribal cultural specialists (appropriate for the resource anticipated) to monitor ground-disturbing activities (for example in geomorphic settings, such as in shifting sands, where buried deposits may be present) in cases where there is a probability of encountering cultural resources during construction that could not be detected during prior Class III inventories.
- **CR-C-8** The BLM shall encourage the use of previously disturbed lands and lands determined by archeological inventories to be devoid of historic properties.

B.3.3 Operations

- **CR-O-1** The project developer shall arrange for BLM and Tribal guests to have access to historic properties within fenced off areas around solar arrays.

B.3.4 Decommissioning/ Reclamation

- **CR-D-1** The BLM shall consider whether further planning for treatment of historic properties or planning for mitigation addressing reclamation activities

will be required (including applicability of training requirements for any reclamation crews in accordance with the WEAP as noted above).

- **CR-D-2** The BLM shall consult SHPOs/THPOs and Indian Tribes prior to and during any reclamation activities affecting areas and resources of importance to Indian Tribes.
- **CR-D-3** The BLM shall consider the timeframe and resources necessary to reclaim certain environments (i.e., desert environments). Developers shall be prepared to use plugs, plantings, or more effective forms of reclamation for desert environments.
- **CR-D-4** The project owner/operator shall notify the BLM prior to the demolition or substantial alteration of any building or structure. If judged necessary by the BLM, the owner/operator shall evaluate the structures for their significance employing professionally qualified architects or architectural historians. If structures slated for demolition are found to be eligible for listing on the NRHP, they shall be recorded to Historic American Building Survey and/or Historic American Engineering Record standards before alteration or removal.
- **CR-D-5** Project owners/operators shall confine soil-disturbing decommissioning and reclamation activities to previously disturbed areas. Should reclamation activities require the use of non-disturbed lands outside the project footprint and its buffer, these lands shall be inventoried prior to disturbance. Known historic properties shall be avoided during these activities.

B.4 Design Features for Ecological Resources (ER)

Design features addressing potential impacts on ecological resources (terrestrial and aquatic habitat, plant communities, fish and wildlife species, and special status species [SSS][2]) in general during the various project phases (Site Characterization; Siting and Design, Construction, Operations; and Decommissioning/Reclamation) are presented in the following sections. Many design features are similar for the different types of ecological resources. They were identified to avoid, minimize, and/or compensate for impacts on ecological resources from utility-scale solar energy development on BLM-administered lands.

B.4.1 General

Project developers shall coordinate with the BLM early in the project planning process and throughout the project to identify, avoid, minimize, or compensate for impacts on ecological resources, by:

[2] BLM SSS include (BLM Manual 6840 Rel. 6-125, or as revised): (1) species listed as threatened or endangered under the ESA; (2) species that are proposed for listing or candidates for listing under the ESA; (3) federally delisted species (within 5 years of delisting) and; (4) species that are listed by the BLM as sensitive. BLM sensitive species are identified at the state-level by each BLM State Director and are generally those species that are native, occur on BLM lands, and require special management consideration to avoid potential future listing under the ESA.

B.4.1.1 General Habitat Design Features (g)

- **ER-G-1g** Project developers shall coordinate with the BLM and other Federal, state, and local agencies in the early phases of project planning to ensure compliance with Federal and state laws and regulations that address the protection of ecological resources.
- **ER-G-2g** Project developers shall designate a qualified biologist who will be responsible for overseeing compliance with all design features related to the protection of ecological resources throughout all project phases, particularly in areas requiring avoidance or containing sensitive biological resources.
- **ER-G-3g** Project developers shall incorporate occurrence/distribution information, effects, conservation, and mitigation measures for plants, wildlife, special status species, and their habitats in the facility's Dust Abatement Plan.
- **ER-G-4g** Project developers shall develop a restoration plan in coordination with BLM to implement revegetation, soil stabilization, and erosion reduction measures to ensure temporary use areas are restored as soon as possible to as much of a natural, native state as feasible after development activities are completed. Seed mixes should include native, geographically appropriate, pollinator-friendly plant species.
- **ER-G-5g** Project developers shall develop measures for fire management and protection that would minimize the potential for a human- or facility-caused fires potentially affecting ecological resources as well as respond to natural fire situations.
- **ER-G-6g** Project developers shall reduce fire hazard from vehicles and human activities (e.g., instruct employees to use spark arrestors on power equipment, ensure that no metal parts are dragging from vehicles, use caution with open flame, cigarettes).
- **ER-G-7g** Project developers shall minimize the number of vehicles used to access the project site and minimize the number of trips to the project site.
- **ER-G-8g** Project developers shall recontour and restore native plant communities on project roads that are no longer needed in order to increase infiltration and reduce soil compaction.
- **ER-G-9g** Only BLM-approved herbicides can be used and there must be an approved Pesticide Use Proposal (PUP) prior to application of herbicide. Project developers shall limit herbicide use to non-persistent, immobile substances. Only herbicides with low toxicity to wildlife, aquatic species, pollinators, and non-target native plant species shall be used, as determined in coordination with state wildlife agencies and the U.S. Fish and Wildlife Service (USFWS).
- **ER-G-10g** Project developers shall apply all herbicides in a manner consistent with BLM policy, respective state regulations, and their label requirements at a minimum, and consistent with ER-G-9g. Additional conservation or mitigation

measures may be agreed upon through coordination with state wildlife agencies and the USFWS.

- **ER-G-11g** Prior to application of herbicide treatments, project developers shall employ a qualified biologist to conduct surveys for priority wildlife and habitats, such as migratory bird nests or burrows, aquatic habitats, pollinators, and SSS to identify the special measures or BMPs necessary to avoid and minimize impacts to these resources.
- **ER-G-12g** Project developers shall develop and adhere to a Spill Prevention and Emergency Response Plan.
- **ER-G-13g** Project developers shall avoid use of stream channels, steep slopes, sensitive soils, and other sensitive environmental areas for equipment or materials storage or stockpiling; construction staging or maintenance activities; field offices; hazardous material or fuels storage; solid waste, hauling; or placement of temporary access roads. No refueling of equipment will take place within a minimum 100 linear feet of the official high water or wetland boundary to minimize the potential for contamination; greater buffer distances may be necessary and appropriate based on site specific conditions such as steep slopes.
- **ER-G-14g** Project developers shall follow federal and state measures for handling toxic substances to minimize danger to ecological resources from spills.
- **ER-G-15g** Project developers shall maintain Hazardous Materials Spill Kits on site and train personnel in the use of these.
- **ER-G-16g** Project developers shall maintain vehicles and other equipment in proper working condition and store only in designated containment areas where runoff is collected or controlled and located outside of streams, riparian areas, washes, and distributary networks to minimize accidental fluids release and hazardous materials spills.
- **ER-G-17g** Project developers shall immediately contain, report, and clean up hazardous material leaks, spills, or releases, and repair equipment before entering new areas. Removal and disposal of spill and related clean-up materials will occur at an approved off-site waste facility.
- **ER-G-18g** Project developers shall use natural materials such as water, mulch or straw to stabilize road surfaces and soils where needed. If it is necessary to use chemical road sealants and soil stabilizing agents, nontoxic varieties shall be used. External substrates brought onto a project site can contain seeds from invasive species. Project developers shall use weed free mulch, erosion control (straw waddles), gravel, or any external substrates brought onto the site. Project developers shall map the locations of all external substrates brought onto site, and shall provide BLM with the locations of all external substrates. See also AC-general design features (Section B.2.1).

- **ER-G-19g** Project developers shall develop a WEAP to educate workers on the ecological and biological aspect specific to the project site. The educational materials shall include information on ecological protection, SSS and their habitats, relevant design features, etc. The WEAP will be provided to all project personnel prior to entering the project worksite. The WEAP shall be provided on a regular basis to ensure the continued ecological awareness of the project worksite during all phases of the project throughout completion. The base information the WEAP provides shall be reviewed and approved by the BLM prior to the issuance of a Notice to Proceed and incorporate adaptive management protocols for addressing ecological changes over the life of the project, should they occur.

B.4.1.2 General Vegetation Design Features (v)

- **ER-G-1v** Project developers shall plan for and create vegetation management that is consistent with applicable regulations and state agency policies for the control of noxious weeds and invasive plant species.
- **ER-G-2v** Project developers shall coordinate with the BLM on use of native, geographically appropriate certified weed-free seed (where available) and mulching. See also ER-C-3v, ER-D-1g, ER-D-1v, ER-D-2v, GS-C-31, and GS-D-3.
- **ER-G-3v** Project developers shall design projects to avoid, reduce, and compensate for onsite impacts to soils, soil seed banks, and vegetation during construction, operations and maintenance, and decommissioning to the maximum extent feasible. All project plans and appendices shall include measures reinforcing and describing how impacts will be mitigated (i.e., avoided, minimized, and/or compensated), and will include clear compliance metrics.

B.4.1.3 General Aquatic Habitat Design Features (aq)

- **ER-G-1aq** Project developers shall develop a Stormwater Pollution Prevention Plan for each project (including all necessary hydrologic modeling) that avoids changes in surface water or groundwater quality (e.g., chemical contamination, increased salinity, increased temperature, decreased dissolved oxygen, and increased sediment loads) or flow that result in alteration of terrestrial plant communities or aquatic communities in wetlands, springs, seeps, intermittent streams, perennial streams, and riparian areas (including the alteration of cover and community structure, species composition, and diversity) off the project site.
- **ER-G-2aq** Project developers shall avoid and minimize impacts, and/or mitigate unavoidable impacts to jurisdictional and non-jurisdictional wetlands and water resources and follow all applicable provisions of the Clean Water Act (33 USC 1251-1387) and the Rivers and Harbors Act (33 USC 301 et seq.).

B.4.1.4 General Wildlife Design Features (w)

- **ER-G-1w** Project developers shall inform project personnel that only permitted biologists may handle (and for some species, conduct approved protocol surveys for) federally-listed species, eagles, and other migratory birds according to specialized protocols approved by the FWS. Handling for some wildlife species is restricted by state wildlife agencies and requires a permit and/or approved survey protocol and reporting.
- **ER-G-2w** Project developers shall schedule major maintenance or repairs outside critical periods for wildlife (e.g., feeding, breeding, nesting, wintering, migrating), as identified and recommended by the BLM or other Federal and state agencies during site specific planning.
- **ER-G-3w** Project developers shall employ noise reduction devices (e.g., mufflers) to minimize the impacts on wildlife and SSS populations. Explosives shall be used only within specified times and at specified distances from sensitive wildlife or surface waters as established by the BLM or other Federal and state wildlife agencies.
- **ER-G-4w** Project developers shall implement wildlife deterrence techniques at solar facility and transmission infrastructure to dissuade interest and use by species such as common ravens, bears, coyotes, rodents, raccoons, skunks, and feral cats and dogs. Example methods can include (but are not limited to) litter control programs including wildlife-proof garbage receptacles, carcass removal, open water source containment, structural modifications to deter raven nesting, and active monitoring and hazing, as necessary. These measures shall also be included in the WEAP.
- **ER-G-5w** Project developers shall construct, improve, and maintain access roads to minimize potential wildlife/vehicle collisions and facilitate wildlife movement through the project area. Examples include posted speed limits slow enough to facilitate avoidance of collisions with wildlife; fencing to preclude wildlife access to roadways; and installation of overpasses/underpasses to allow wildlife crossings and retain habitat connectivity. See also ER-C-2w.
- **ER-G-6w** Project developers shall limit project vehicle speeds and using shuttle vans and carpooling in areas occupied by special status plants and animal species. Traffic shall yield to wildlife, allowing safe road crossing.
- **ER-G-7w** Project developers shall educate employees and contractors to prevent the collection, harassment, or disturbance of plants, wildlife, and their habitats (particularly SSS) according to applicable state and Federal laws, regulation, and permit requirements and associated plans (for example, WEAP, flagging plan, fencing plan, access management plan), and a robust internal compliance program.
- **ER-G-8w** Project developers shall advise personnel to minimize stopping and exiting their vehicles in the winter ranges of large game while there is snow on the ground.

- **ER-G-9w** Project developers shall immediately report any vehicle-wildlife collisions, and observations of potential wildlife problems, including wildlife injuries or mortality, to the BLM or other appropriate agency authorized officer.
- **ER-G-10w** Project developers shall use road closures or other travel modifications (e.g., lower speed limits, no foot travel) to avoid and reduce impacts to wildlife and SSS during crucial life history periods (e.g., extreme winter conditions, calving/fawning seasons, raptor nesting).
- **ER-G-11w** Project developers shall prohibit project personnel from bringing firearms and pets to project sites.
- **ER-G-12w** For all project phases, project developers shall develop and implement measures to ensure protection of raptors in coordination with appropriate federal and state agencies (e.g., BLM, USFWS, and state resource management agencies). Measures may include reducing the height of towers, reducing the use of cables and guy wires, and considering solar panel designs that reduce impacts on raptors and prey species for raptors.
- **ER-G-13w** Project developers, in coordination with the BLM, USFWS, and other appropriate agencies, shall develop and implement a Bird and Bat Conservation Strategy that includes a Nesting Bird Management Plan to address nest searching and monitoring as part of pre-construction habitat clearance, construction, and operations. Developers shall survey and confirm the species' dispersal prior to proceeding with habitat/resource removal, when necessary. Any habitat clearance shall be scheduled for outside the breeding season, to the extent possible. Consult USFWS Migratory Bird Program for local breeding season at project site and recommended nest buffers to be used in the Nesting Bird Management Plan. The Bat Conservation Strategy shall include a description of available information; survey requirements, recommendations for mitigation measures (i.e., avoidance, minimization, and compensation) if high concentrations of bats or important bat colonies, hibernacula, or other habitats (e.g., roosting sites, migratory paths, important foraging habitat or plants (e.g., agave), permanent water sources) occur; and monitoring and adaptive management strategies
- **ER-G-14w** Project developers shall develop and implement (in coordination with the BLM and USFWS) strategies for complying with regulatory requirements of the Bald and Golden Eagle Protection Act. For example, adhering to instruction in the most current bald and golden eagle guidance or pursuing an eagle take permit if it is not practicable to comply with applicable guidelines. The analysis of potential impacts on, and mitigation for, eagles shall be made in coordination with the USFWS.
- **ER-G-15w** Project developers shall develop and implement (in coordination with appropriate federal and state agencies]e.g., BLM, USFWS, and state wildlife management agencies]) measures to protect birds (including migratory species protected under the Migratory Bird Treaty Act [MBTA]).

- **ER-G-16w** Project developers shall reduce the likelihood of adverse impacts to wildlife from open-topped, uncapped hollow pipes or tube-like structures by ensuring that designs for new construction and/or the modification of facilities does not include open-topped vertical pipes that are 12 inches or less in diameter.
- **ER-G-17w** Project developers shall reduce the likelihood of adverse impacts on wildlife from water developments by ensuring that all water developments except for naturally occurring waters or closed tanks are not accessible to wildlife, and shall have escape ramps installed immediately upon completion of construction and before use. Prior to installation of escape ramps, all open pits and trenches will be inspected at least 3 times daily by a qualified biologist to identify and rescue any trapped animals; at least one of the inspections will be at sunrise to ensure that any trapped reptiles are rescued prior to warming temperatures.
- **ER-G-18w** The following information will be included, as appropriate, in the planning criteria/analysis of the management situation document, National Environmental Policy Act (NEPA) documents, and decision documents:
    - Disclose all areas of habitat connectivity within the planning area, including the location, habitat components, and species for which each was assessed.
    - Describe how management of areas of habitat connectivity would occur under each alternative.
    - As appropriate, incorporate adaptive management (i.e., monitoring requirements, trigger thresholds, and management responses) into management direction and allocation decisions to provide for future management of habitat connectivity if disturbances alter habitats, species' needs or distributions change, future climate projections are refined, etc.
    - Identify any analysis issues, analytical frameworks for analysis, and the approach for analyzing the effects of BLM decisions on the management of areas of habitat connectivity across alternatives, including trade-offs associated with impacts to habitat connectivity across the alternatives.

B.4.1.5 General Special Status Species Design Features (sss)

- **ER-G-1sss** Project developers shall develop a threatened and endangered species protection plan at each project location. The U.S. Fish and Wildlife Land-Based Wind Energy Guidelines. (https://www.fws.gov/sites/default/files/documents/land-based-wind-energy-guidelines.pdf) is one source for related guidance on plan development). All relevant exclusions and design features for threatened, endangered, and other SSS species will be clearly identified in the species protection plan. Project developers shall coordinate with the BLM and USFWS to develop the threatened and endangered species protection plan and include proactive conservation measures as appropriate and feasible.

- **ER-G-2sss** Project developers shall conduct pre-construction surveys for SSS, in coordination with BLM, USFWS, and federal and state agency laws, regulations, programs, and policies.
- **ER-G-3sss** As part of the threatened and endangered species protection plan, project developers shall include a transplantation plan for SSS that will be directly impacted by facility development if impacts are unavoidable if proven that transplantation works for the specific species, and if approved by USFWS (for ESA threatened and endangered species), BLM, and/or state wildlife agencies.
- **ER-G-4sss** Project developers shall develop and implement measures to ensure mitigation (i.e., avoidance, minimization), monitoring, and adaptive management of impacts on special status and priority species in coordination with appropriate federal and state agencies (e.g., BLM, USFWS, and state resource management agencies). Compensatory mitigation will be required when resource impacts cannot be avoided.
- **ER-G-5sss** Project developers shall acquire and protect, in perpetuity, compensation habitat to offset (i.e., no net habitat loss or net benefit; BLM H-1794-1 Rel. No. 1-1808) for aquatic species, wildlife, and SSS. The acreages will be based upon final calculation of impacted acreage. Acreages will be adjusted as appropriate for other alternatives or future modifications during implementation. Compensation will be provided for impacts at a ratio determined by the BLM consistent with applicable mitigation policy. For example, suggested ratios for loss of Mojave desert tortoise and Mohave ground squirrel are 5:1 (in same critical habitat unit) and 2:1, respectively, for renewable energy development under the Desert Renewable Energy Conservation Plan. However, the USFWS and state resource management agencies shall be consulted for species and habitat-specific mitigation ratio requirements. See also ER-G-10sss.
- **ER-G-6sss** Project developers shall incorporate into a WEAP the key elements on the identification and protection of SSS, including required design features. The WEAP for SSS will be provided to all project personnel prior to entering the project worksite. The WEAP shall be provided on a regular basis, and updated as needed to ensure continued ecological awareness of the project worksite during all phases of the project's life. The base information the WEAP provides shall be reviewed and approved by the BLM prior to the issuance of a Notice to Proceed and incorporate adaptive management protocols for addressing ecological changes over the life of the project, should they occur.
- **ER-G-7sss** Project developers shall identify in the threatened and endangered species protection plan (ER-G-1sss) and conduct seasonally appropriate inspections by a federally permitted biologists or team of biologists to determine presence and locations of SSS or their habitats in or near project areas. Attendees at the inspections shall include appropriate Federal agency representatives, state natural resource agencies, and construction contractors, as appropriate. Habitats or locations to be avoided shall be clearly marked. Project developers shall consult with the USFWS upon discovery of federally

listed threatened and endangered species during any phase of project design, implementation, operation and maintenance, or post-development restoration. An appropriate course of action shall be determined to avoid, minimize, or compensate impacts. All applicable terms and conditions and conservation measures listed in the USFWS programmatic Biological Opinion shall be followed.

- **ER-G-8sss** Project developers shall ensure consistency and proactive implementation of recovery actions and recommendations in USFWS recovery plans for impacted ESA-listed species and conservation/agreements strategies for impacted SSS.
- **ER-G-9sss** Project developers shall develop and implement a proactive conservation efforts from recovery plans or conservation agreements/recovery efforts to assist with conservation and recovery of special status species above and beyond that required by regulatory processes. Proactive conservation efforts will be developed in consultation with the BLM, USFWS and relevant state resource agencies.
- **ER-G-10sss** Project developers shall implement compensatory mitigation, monitoring, and adaptive management of direct, indirect, and cumulative impacts on, and loss of habitat for, SSS. Project proponents will provide compensatory mitigation for loss of habitat for federally listed species as coordinated and agreed to by BLM, USFWS (for threatened and endangered species), and/or state wildlife agencies. Mitigation may be in the form of land acquisition and/or funding/implementing conservation actions that will benefit the recovery of federally listed species. See also ER-G-5sss.
- **ER-G-16sss** There shall be no helicopter activities within 4 miles (6.4 km) of sage grouse leks in the springtime in order to minimize disturbance to lekking birds.
- **ER-G-17sss** In grizzly bear habitat, project developers shall follow the Interagency Grizzly Bear Committee attractant storage requirements (igbconline.org) or BLM Field Office or Statewide Order requirements. Project developers shall also notify the FWS Grizzly Bear Recovery Office of any grizzly bear/human conflicts, within 24 hours after they occur at (406) 329-3239. Conflict is any interaction between humans and bears in which they were surprised, attacked, charged, deployed bear spray, or defended themselves in any way, and/ or conflict where a grizzly bear is expected to have received a reward from an attractant (e.g. food, animal carcass (including livestock), grills, stoves, dirty pots and pans, bird feeders, garbage), or any other suspected occurrence where a bear could associate activities with an attractant. Also see ER-C-26sss, ER-C-27sss, and ER-O-8sss.

B.4.2 Site Characterization, Siting and Design, Construction

B.4.2.1 General Habitat Design Features

- **ER-C-1g** The BLM will include USFWS and relevant state resource agencies in the baseline needs assessment to identify any needed baseline studies relevant to their trust resources, and the relevant analyses needed in the BLM NEPA documentation.
- **ER-C-2g** Project developers shall contact appropriate agencies (e.g., BLM, USFWS, and state resource management agencies) early in the project planning process to identify, avoid, and minimize direct and indirect impacts to potentially sensitive ecological resources including, but not limited to, waters of the United States, surface waters of the State, and other aquatic features (such as rivers, lakes, wetlands (both jurisdictional and non-jurisdictional), springs, seeps, streams (ephemeral, intermittent, and perennial), 100-year floodplains, ponds, fens, or playas); vulnerable, rare, or unique biological communities (such as biological soil crusts, remnant vegetation associations, wetland and riparian habitats, occupied and essential habitats for special status species, designated and proposed critical habitats); and other culturally important habitats, such as priority habitats and crucial wildlife habitats located within or in the vicinity of the areas occupied by the proposed solar energy facility and associated access roads and ROWs (action area).
- **ER-C-3g** Project developers shall establish avoidance areas around sensitive habitats as necessary to prevent destructive impacts associated with project activities (e.g., identified in the applicable land use plan or substantiated by best available information or science in consultation with the BLM, USFWS, and other credible experts as appropriate). Sensitive habitats and plant communities could include springs, fens, playas, riparian areas, mesquite bosques, microphyll woodlands, sand dunes, desert washes, etc. Appropriate avoidance areas will be developed depending the ecosystem function necessary to maintain these habitats and vegetation types, and on the species using these habitats (*i.e.,* migratory birds, invertebrates, special status species), as well as processes that are required to maintain habitats (*i.e*., groundwater discharge, sand transport, habitat connectivity).
- **ER-C-4g** Project developers shall site and design project activities away from crucial winter ranges and habitats occupied by priority species.
- **ER-C-5g** Project developers shall site and design project activities to avoid or reduce impacts to protected areas, wilderness areas, and other lands with special designations for wildlife (e.g., BLM ACECs). Areas designated by other organizations (e.g., Important Bird Areas [IBAs, Priority Amphibian and Reptile Conservation Areas [PARCAs] may also be considered, Appropriate spatial buffers will be established based on coordination with relevant state and federal agencies (e.g, local landowner or land management agency) where facilities will not be authorized or sited.

- **ER-C-6g** Project developers shall maintain areas in as natural a condition as possible within safety and operational constraints.
- **ER-C-7g** Project developers shall, wherever feasible, collocate solar development with parking lots, landfills, rooftops, abandoned mine lands, or other developed sites and locate staging and parking areas within the disturbed footprint of the solar energy facility to minimize habitat disturbance.
- **ER-C-8g** Project developers shall, to the maximum extent practicable, span important or sensitive habitats with transmission line conductors within the limits of standard structure design.
- **ER-C-9g** Project developers shall coordinate with BLM, USFWS, state wildlife, and other relevant resource agencies, and use available data, including but not limited to biological resource models and survey results (which could include maps or databases), that show the location of sensitive resources to establish the layout of roads, power lines, fences, and other infrastructure in a manner that avoids direct and indirect impacts to these resources to the maximum extent practicable.
- **ER-C-10g** Project developers shall, to the maximum extent practicable, restrict construction activity to existing roads, routes, and utility corridors to minimize the number and length/size of new roads, routes, disturbance, laydown, and borrow areas.
- **ER-C-11g** Project developers shall delineate proposed disturbance boundaries with temporary construction fencing and flagging prior to construction and confine disturbances, project vehicles, and equipment to the delineated project areas to protect and conserve sensitive resources and species of interest (e.g., special status species, state-managed wildlife species), habitats, and plant communities.
- **ER-C-12g** Project developers shall, to the extent practicable, minimize the area disturbed by pre-construction site monitoring and testing activities and installations.
- **ER-C-13g** Project developers shall monitor, avoid, and minimize cumulative temperature changes to plant communities and wildlife habitat, both in and outside of solar facilities, based on current research. Unavoidable impacts will require compensatory mitigation.
- **ER-C-14g** Project developers shall use rolled and compacted onsite construction access routes, as appropriate, to allow trucks and equipment to access construction locations.
- **ER-C-15g** To the maximum extent practicable developers shall confine vehicular traffic to designated open routes of travel to and from the project site, and prohibit, within project boundaries, cross- country vehicle and equipment use outside of approved designated work areas to prevent unnecessary ground and vegetation disturbance.

- **ER-C-16g** Project developers shall minimize, to the maximum extent practicable, roads, power lines, fences, and other infrastructure associated with a solar development project.
- **ER-C-17g** Project developers shall design and conduct activities proposed within and near Aeolian sand transport corridors (including areas where sediment enters the corridor) to: (1) maintain the quality and function of Aeolian transport corridors and sand deposition zones, unless related to maintenance of existing facilities/operations/activities; (2) avoid a reduction in sand-bearing sediments within the Aeolian system; (3) minimize mortality to dunes associated with sand dependent species.
- **ER-C-18g** Project developers shall stabilize disturbed areas following grading in a manner appropriate to the soil type so that wind or water erosion is minimized.
- **ER-C-19g** Project developers shall maximize the use of helicopters where access roads do not exist or where access roads could not be constructed without significantly impacting habitats.
- **ER-C-20g** Project developers shall maximize the use of materials such as tundra pads or other temporary road mats for temporary construction roads and other temporary facilities.

B.4.2.2 Design Features Specifically for Vegetation (v)

- **ER-C-1v** Project developers and/or BLM shall consult with the appropriate FWS field office for site/species specific spatial and temporal buffer recommendations for threatened, endangered, and other SSS (e.g., blooming timing limitations).
- **ER-C-2v** Project developers shall not utilize construction practices such as grading, disc and roll, and other techniques that disturb soil and completely remove vegetation in the solar field area (areas between and under solar panels).
- **ER-C-3v** Project developers shall coordinate with the BLM on use of native, geographically appropriate seed mixes to restore vegetation/plant communities in each solar panel array block to conditions specified in the revegetation/ reclamation/restoration plan to the maximum extent possible as soon as construction is complete. Restoration will include temporary and permanent disturbances and will continue for as long as need to reach pre-disturbance or reference conditions. Protocols for inventorying the percentage of vegetation crushed during construction and adaptive strategies to restore native vegetation would be included in the Restoration Plan as well as specific guidance for requirements for the timelines, methods, and standards required for both temporary restoration and long-term restoration (post-decommissioning). See also ER-G-2v, ER-D-1g, ER-D-1v, ER-D-2v, GS-C-31, and GS-D-3.
- **ER-C-4v** Project developers shall utilize Access Management Planning to limit disturbance within the panel blocks.

- **ER-C-5v** To reduce erosion and habitat loss, project developers shall minimize natural vegetation removal. Preferred techniques include use of overland travel methods or hand-cutting/mowing vegetation rather than removing entirely. Locations for use of overland travel or hand-cutting/mowing would be determined in conjunction with the Access Road Plan.
- **ER-C-6v** Project developers shall use techniques (e.g., raising height of solar panels, increased spacing between panels, minimizing project footprint; using temporary fencing) to retain high percentages of native vegetation and biological soil crusts onsite and beneath and between solar panels as compared to a reference site or pre-construction conditions at the project site.
- **ER-C-7v** Project developers shall analyze effects of different panel types, panel heights, and spacing on solar exposure, temperature, and soil moisture with respect to native vegetation and plant community survival, composition, density, and cover, and design facilities to avoid or minimize adverse effects on native plant establishment, reproduction, and growth.
- **ER-C-8v** Project developers shall, to the maximum extent practicable, avoid development in areas with Joshua trees (*Yucca brevifolia/ jaegeriana*), substantial patches of other Yucca species, agave, and saguaros due to these species importance for many SSS, including pollinators and nectivorous bat and bird species.
- **ER-C-9v** Where avoidance is not practicable, project developers shall develop a minimization and mitigation strategy specific to Yucca, agave, and cactus species in coordination with the applicable local BLM, federal (USFWS for threatened and endangered species), and state management agencies.
- **ER-C-10v** Following construction, project developers shall revegetate the solar array area with native plant communities to the maximum extent practicable. See also ER-G-2v, ER-C-2v, ER-D-1g, ER-D-1v, ER-D-2v, GS-C-31, and GS-D-3.
- **ER-C-11v** Project developers shall prevent establishment and spread of invasive species and noxious weeds within the ROW and in associated areas where there is ground surface disturbance or vegetation cutting during development and management of all project sites. This includes creating a vegetation/weed management plan, in coordination with BLM, for species most likely to spread. Project developers shall carry out integrated weed management actions during all phases of activities and at a minimum will include the following:
    - clear treatment timelines, removal and treatment timelines, and remedial actions for weed management;
    - a plan to monitor and quickly implement control measures to ensure early detection and eradication of weed invasions to avoid the spread of invasive weeds and non-native species on site and to adjacent off-site areas.
- **ER-C-12v** Project developers shall ensure vehicles and equipment are free from invasive plants. Establish a controlled inspection and cleaning area to wash and

visually inspect construction equipment and vehicles arriving at the project area and to remove soil and collect seeds that may be adhering to tires and other equipment surfaces. All equipment must be pressure washed prior to entering new areas.

B.4.2.3 Design Features Specifically for Aquatic Habitat (aq)

- **ER-C-1aq** Project developers shall work with BLM and applicable state and Federal agencies early in the design process to avoid large drainages and maintain water flow. If multiple projects are in proximity, encourage applicants to align drainage avoidance areas to maintain water flow throughout the landscape.
- **ER-C-2aq** Project developers shall avoid, to the maximum extent practicable, disturbance within a minimum 300 feet of riparian habitats, wetlands, and other aquatic habitats, and possibly larger buffers dependent on soils, slopes, and wildlife and SSS habitat needs.
- **ER-C-3aq** Project developers shall identify site-specific surface water runoff patterns and implement measures to prevent excessive and unnatural soil deposition and erosion. Project developers shall not impede natural perennial and ephemeral surface water flows and shall implement measures to maintain natural drainages and hydrologic function in the event drainages are disturbed.
- **ER-C-4aq** Project developers shall use appropriate erosion control measures in construction and operation to eliminate or minimize runoff into water bodies.
- **ER-C-5aq** Project developers shall minimize, to the maximum extent possible, removal of vegetation that provides shading to aquatic resources to prevent water temperature increases.
- **ER-C-6aq** Project developers shall work with BLM and applicable agencies (e.g., USFWS, Army Corps of Engineers, state wildlife agencies) to establish avoidance areas, buffers or setbacks for activities that occur near riparian or wetland habitats to minimize effects to sensitive resources and species of interest (federally listed, state listed, BLM focus or SSS).
- **ER-C-7aq** Project developers shall shall coordinate with BLM, USFWS, and state wildlife agencies and avoid entry into aquatic habitats, such as streams, springs, and riparian areas, during site characterization, desig, and construction activities until surveys by qualified biologists have identified presence of unique flora and fauna and/or their habitats (e.g., BLM special status species, state-managed wildlife, pollinators) to be present and avoidance and minimization strategies are developed and implemented.
- **ER-C-8aq** Project developers shall design project facilities to reduce the number of stream crossings within a particular stream or watershed (e.g., access roads and utilities could share common ROWs, where feasible), and locating facilities in pre-disturbed areas to reduce watershed impacts and potential for wildlife and SSS habitat fragmentation.

- **ER-C-9aq** Project developers shall use temporary bridges over waterways when temporary access is needed across waterways, and limit the use of low-water crossings (fords). If low water crossings are the only option available, project developers shall ensure usage during the driest time of the year and use rocked approaches on the shorelines. Any water crossings shall be returned to pre-existing stream channel conditions after the need for the crossing has passed. USFWS and state wildlife agencies shall be consulted to determine impacts and mitigation (e.g., avoidance, minimization) strategies for fish, wildlife, and SSS in low water crossing areas.
- **ER-C-810aq** If equipment with hydraulic lines is used within streams, riparian areas, wetlands or near springs, project developers shall ensure the hydraulic fluid being used in the equipment is non-toxic to aquatic species and have a correlating spill prevention plan.
- **ER-C-11aq** Project developers shall design necessary stream crossings to provide in-stream conditions that allow for and maintain uninterrupted movement and safe passage of fish and other aquatic species throughout project construction and operations.
- **ER-C-12aq** Project developers shall avoid placement of transmission towers within aquatic and wetland habitats, or other sensitive habitats such as riparian habitats. If towers must be placed within these habitats, they shall be designed and installed to not impede flows or fish passage, and to minimize impacts to aquatic species.
- **ER-C-13aq** Project developers shall design transmission lines such that adequate height clearance is provided for riparian vegetation including riparian trees.
- **ER-C-14aq** Project developers shall reduce the amount of area covered by impervious surfaces through use of permeable pavement or other pervious surfaces.
- **ER-C-15aq** Project developers shall, where applicable, utilize block or check valves on both sides of waterways and riparian/riverine habitat to minimize product release from pipelines that transport hazardous liquids (e.g., oils) that pass through aquatic or other habitats. Such pipelines shall be constructed of double-walled pipe at river crossings.
- **ER-C-16aq** Project developers shall design any proposed stabilization structures to incorporate bioengineering principles (e.g., use living and nonliving plant materials in combination with natural and synthetic support materials for slope stabilization, erosion reduction, and vegetative establishment.
- **ER-C-17aq** Project developers shall operate equipment such as backhoes, excavators, dump trucks, and cranes from the top of bank or along the shore where possible and not enter the waterway, unless work area isolation would result in less habitat disturbance.

- **ER-C-18aq** Any structure that protrudes into a stream shall be designed by a professional engineer/hydrologist experienced in the design of such structures.
- **ER-C-19aq** If used, project developers shall key the largest riprap/rock material into the toe of the bank.
- **ER-C-20aq** Project developers shall maintain the existing channel form and dimension to the maximum extent possible.
- **ER-C-21aq** If using wood, project developers must use wood that is intact, hard, and undecayed to partly decaying with untrimmed root wads to provide functional refugia habitat for fish. Wood shall be obtained from outside of the channel.
- **ER-C-22aq** Project developers shall use lean natural angular rock or stone may be used to anchor or stabilize large wood, fill scour holes, prevent scouring or undercutting of an existing structure, or to construct a barb, weir or other properly designed and approved in-water structure. The use of rock or stone shall comply with Corps of Engineers' policy on prohibited materials.
- **ER-C-23aq** Project developers shall individually place rock riprap without end dumping.
- **ER-C-24aq** All repairs of previously existing bank protection structures shall incorporate bioengineering principles, with minimal use of clean natural rock or stone and maximum revegetation of the bankline above the ordinary high water mark. If the entire structure has been destroyed or damaged beyond repair, replacement of the structure shall utilize bioengineering principles and methods, and will incorporate native vegetation.
- **ER-C-25q** Project developers shall ensure equipment and vehicles are cleaned prior to use such that invasive seed materials are not carried into aquatic habitats such as streams, riparian areas, wetlands and springs.
- **ER-C-26aq** Project developers shall submit a jurisdictional delineation for consultation with the USACE, in accordance with the Clean Water Act Section 404, Executive Orders 11988 (Federal Register, Volume 42, page 26951, May 24, 1977) and 11990 (Federal Register, Volume 42, page 26961, May 24, 1977), and the revised definition of the Water of the United States (Federal Register, Volume 88, page 61964, September 8, 2023) for avoidance, minimization and compensation proposals.
- **ER-C-27aq** Project developers shall identify and analyze a Least Damaging Practicable Alternative (LEDPA) within the environmental analysis. A USACE permit, Nationwide verification, or approved jurisdiction letter shall be provided to the BLM prior to a decision.
- **ER-C-28aq** Project developers shall minimize effects from groundwater or surface water extraction and discharge activities by conducting hydrologic studies during project planning. See also design features at B.20.1.2 (for hydrologic impacts).

- **ER-C-29aq** Project developers shall coordinate with BLM and relevant federal and state resource and wildlife agencies to avoid development in and adjacent to ephemeral washes and vegetated washes, to the maximum extent practicable, and avoid development within a minimum 200 ft of these washes, or greater depending on slope and soil conditions.

B.4.2.4 Design Features Specifically for Wildlife(w)

- **ER-C-1w** Project developers shall minimize the number of areas and structures where wildlife could hide or be trapped (e.g., open sheds, pits, trenches, uncovered basins, and laydown areas) and provide ramps or other features to ensure animals can escape these sites.
- **ER-C-2w** Project developers shall maximize the preservation of wildlife and SSS connectivity corridors using novel construction methods, site designs, corridor avoidance, wildlife crossings, and fencing designs. Each will be evaluated and studied as needed to improve connectivity. This includes maintaining wildlife and SSS corridors of sufficient width, as determined by site-specific analysis, and field verification of permeability for wildlife. Project developers shall design and install fences that reduce impacts to wildlife and allow for wildlife passage when appropriate. Allow for wildlife movement through fencing via lifted fencing or by creating wildlife access gates. Fencing design shall incorporate best available science and technology advances and be approved by federal and state wildlife agency biologists to ensure local species needs are considered. See also ER-G-18w.
- **ER-C-3w** Project developers shall monitor and repair any fencing on at least a quarterly basis for possible damage, structural integrity, and unintended openings.
- **ER-C-4w** Project developers shall coordinate with BLM, USFWS, and state wildlife agencies to plan monitoring, capture, and relocation of animals that could be harmed and are unable to leave the site on their own. Project developers will use an adequate number of qualified biological monitors (as determined by the federal authorizing agency, relevant state wildlife agency, and USFWS) to be onsite during initial site preparation and during the construction period. Federal and state permits may be required for many species.
- **ER-C-5w** Only authorized biological monitors with required state and Federal handling permits shall relocate wildlife found in harm's way from the area of the activity.
- **ER-C-6w** Project developers shall, to the extent practicable, locate meteorological towers, solar sensors, soil borings, wells, and travel routes to avoid areas where wildlife may be sensitive to human activities or habitat loss/fragmentation.
- **ER-C-7w** Project developers shall avoid the use of evaporation ponds for water management when the water could harm birds or other terrestrial wildlife due to constituents of concern present in the wastewater (e.g., selenium, hypersalinity,

etc.). Evaporation ponds will be configured to minimize attractiveness to shorebirds (e.g., maintain water depths over two feet; maintain steep slopes along edge; enclose evaporation ponds in long-term structures; or obscure evaporation ponds from view using materials that blend in with the natural surroundings).

- **ER-C-8w** Project developers shall cover or secure (with covers/lids) potable and non-potable water sources (tanks, ponds, and pipes) to prevent animals from entering. If covers/lids are not possible to ensure coverage of water sources, or 2-cm netting can be considered. Covers or netting shall be maintained and monitored on a regular basis to ensure animals are not trapped and the covers/netting are in good condition.
- **ER-C-9w** Project developers shall minimize wildlife entrapment and entanglement hazards via project design measures that include:
    - Installation of anti-perch devices where birds commonly nest or perch.
    - Covering or enclosing all potential nesting surfaces with mesh netting or other exclusion material. Exclusion material must have no opening or mesh size greater than 19 mm and must be maintained and monitored to prevent nesting or entrapment.
    - Cap pipes and cover/seal all small dark spaces where birds/wildlife may enter and become trapped.
    - All open-air tanks (e.g., water storage) throughout the project's lifespan must have escape ramps for wildlife.
- **ER-C-10w** Project developers shall ensure that all relevant information from DOI Secretarial Order 3362: Improving Habitat Quality in Western Big Game Winter Range and Migration Corridors has been incorporated as necessary.
- **ER-C-11w** Project developers shall, to the extent practicable, avoid siting solar power facilities near open water or other areas that are known to attract large numbers of birds.
- **ER-C-12w** Project developers shall avoid siting projects in or near key migratory flyways or pathways for water-associated birds where feasible. If impacts to migrating water-associated birds that pass through the project areas are anticipated then consider mitigation on their breeding or wintering grounds. Mitigation shall be determined in coordination and as agreed to by BLM, USFWS, and state wildlife agencies.
- **ER-C-13w** Project developers shall hire qualified biologists to conduct pre-construction/activity nesting bird (e.g., special status species, migratory birds, raptors) surveys according to USFWS and state wildlife agency-approved protocols.
- **ER-C-14w** Project developers shall conduct all vegetation removal or disturbance activities outside of bird breeding season, in order to avoid impacts to nesting birds protected by the Migratory Bird Treaty Act and the ESA. Project developers shall consult with local BLM biologists, the USFWS, and state wildlife

agencies to ensure breeding season dates reflect local breeding circumstances. If construction involving vegetation removal/disturbance must be scheduled during the breeding season for migratory birds, a qualified biologist must perform a nest survey within a 150-foot (ft) radius of the construction areas no more than three days prior to the occurrence of any ground disturbance. If active nests are detected, the nest area shall be mapped and flagged when appropriate, and no activity shall take place near the nest (at a distance determined by the BLM in coordination with the USFWS and/or appropriate state agencies), or until the appropriate agencies agree that construction can proceed with the incorporation of agreed-upon monitoring measures.

- **ER-C-15w** Project developers shall avoid habitat-altering activities during bird breeding season, to the extent possible. If a project-related activity must occur during the breeding season, a qualified biologist shall survey the area for nests immediately prior to commencing construction activities. If active nests are detected, the nest area shall be flagged, and no activity shall take place near the nest (flagging and avoidance distances must be done in coordination/consultation with BLM and USFWS and/or appropriate state agencies – Flagging, for example, may be inappropriate and not allowed for nests of ESA-threatened or endangered bird species), or until the appropriate agencies agree that construction can proceed with the incorporation of agreed-upon monitoring measures.
- **ER-C-16w** Project developers shall develop and implement avoidance areas and/or buffers for activities proposed near occupied maternity bat roosts or presumed occupied maternity roosts and hibernacula. Specifically, avoid tree clearing activities within a minimum 0.25 miles of hibernacula during the active season; 0.25 miles of known roosts during the active season; 1.5 miles of capture or acoustic records or areas with assumed presence.
- **ER-C-17w** Project developers shall, to the extent practicable, minimize the number of tall structures, such as meteorological towers, and avoid their placement along known flight paths of birds and bats. The use and number of guy wires shall also be minimized to the extent practicable. Any guy wires shall be marked sufficiently to warn birds and bats of their placement.
- **ER-C-18w** Project developers shall follow guidelines for lighting provided by USFWS for communication or other towers both above and below 350' above ground level. See https://www.fws.gov/story/incidental-take-beneficial-practices-communication-towers or contact FWS for latest guidance
- **ER-C-19w** Project developers shall implement current guidelines and methodologies in the design and analysis of proposed transmission facilities in order to minimize the potential for raptors and other birds to collide or be electrocuted by them.
- **ER-C-20w** Project developers shall place low and medium voltage connecting power lines associated with the solar energy development underground to the extent possible, unless burial of the lines is prohibitively expensive (e.g., where

shallow bedrock exists) or where greater adverse impacts to biological resources would result.

- Overhead lines may be acceptable if sited away from high bird crossing locations (e.g. roosting and feeding areas or between lakes, rivers, Lesser prairie chicken, prairie grouse and sage grouse leks, and nesting habitats), to the extent practicable. To the extent practicable, the lines shall be marked in accordance with Avian Power Line Interaction Committee (APLIC) collision guidelines.
- Overhead lines may be used when the lines parallel tree lines, employ bird flight diverters, or are otherwise screened so that collision risk is reduced.
- Above-ground low and medium voltage lines, transformers, and conductors shall follow the 2006 or most recent APLIC "Suggested Practices for Avian Protection on Power Lines" implementing current guidelines and methodologies in the design and analysis of proposed transmission facilities in order to minimize the potential for raptors and other birds to collide or be electrocuted by them.

- **ER-C-21w** Project developers shall design transmission line support structures and other facility structures to discourage use by raptors for perching or nesting (e.g., by using monopoles rather than lattice support structures or by use of anti-perching devices).
- **ER-C-22w** Project developers shall either avoid placing gen-tie lines or bury lines when located within 0.7 mi of known pinyon jay colony locations. Larger buffers may be required based on site-specific conditions and analyses. Temporal buffers (generally March through May, or as based on site specific biological information) shall also be implemented to avoid and minimize impacts during the pinyon jay nesting/brood rearing season.
- **ER-C-23w** Project developers shall, to the extent practicable, avoid siting solar project facilities within a minimum buffer distance of 2 milesin or near concentrated raptor prey base areas, such as prairie dog towns, ground squirrel colonies, grouse leks, and fawning areas, although the required buffer distance could be larger depending on site specific conditions and species.
- **ER-C-24w** Project developers shall not allow disturbance within 500 m of black-tailed prairie dog towns.
- **ER-C-25w** Project developers shall avoid, minimize, and/or mitigate impacts to monarch butterflies and other pollinators. Minimization measures shall include existing strategies (e.g., Western Monarch Butterfly Conservation Recommendations [USFWS 2023]; BLM Strategic Plan for Pollinator Conservation). Mitigation measures to offset impacts shall include efforts to conserve and restore important habitats for western monarch butterflies and other pollinators with the same area/region/flyway as impacts.

B.4.2.5 Design Features Specifically for Special Status Species (sss)

- **ER-C-1sss** Project developers shall develop, in coordination with state wildlife agencies and the USFWS and/or National Marine Fisheries Service (NMFS), the level and extent of surveys required to determine effects and avoid occupied habitats and connectivity corridors for special status species, and other plant and wildlife species of concern, in all solar development project areas.
- **ER-C-2sss** Project developers shall conduct project clearance surveys for BLM special status plant and animal species, in coordination with BLM, USFWS, NMFS, state wildlife agencies, and, as applicable, Tribes and consistent with relevant statutes, regulations, programs, policies, permit requirements, and survey protocols or standards, prior to receiving land use authorizations for the purpose of informing analyses necessary for BLM compliance with the NEPA, FLPMA, and, as applicable, the ESA
- **ER-C-3sss** Project developers in coordination with BLM and relevant state and Federal agencies (e.g., USFWS, NMFS, state wildlife agencies) shall identify exclusion or avoidance areas in all occupied habitat for special status species, including necessary seasonal and spatial buffers (during construction, operation, and reclamation phases) to protect species and their habitats from direct and indirect impacts associated with solar development, where not otherwise excluded. Project developers will refer to and incorporate the programmatic exclusion areas for threatened and endangered species critical and occupied habitats and relevant conservation agreements/strategies.
- **ER-C-4sss** Project developers shall avoid direct disturbance of occupied habitat for threatened, endangered, and proposed plant species to the maximum extent practicable, including implementation of appropriate avoidance areas established with the local BLM, USFWS, and state management agencies. Avoidance areas shall consider pollinator habitat and habitat connectivity. Project developers will refer to and incorporate the programmatic exclusion areas for threatened and endangered plant species critical and occupied habitats and relevant conservation agreements/strategies.
- **ER-C-5sss** The BLM shall require compensatory mitigation for any residual unavoidable impacts to special status species and their habitats (e.g., occupied, migratory, habitat connectivity, roosting, breeding, nesting). Compensatory mitigation shall be developed in accordance with direction and recommendations provided by the BLM Mitigation Policy (BLM MS-1794) and BLM Mitigation Handbook (BLM H-1794-1), including any future revisions. Compensatory mitigation for threatened and endangered species and their habitats must: 1) achieve a net benefit, consistent with applicable law, to a level that would improve upon the baseline conditions of the species available habitat or population status, and 2) be durable, i.e., it will be effective for at least the duration of the impacts resulting from the associated public land use.
- **ER-C-6sss** Project developers shall review the FWS's Information for Planning and Consultation (IPaC; https://ipac.ecosphere.fws.gov/) and coordinate with

state resource agencies for updated information (e.g., occurrences and distribution) and recommended conservation measures for ESA-listed, candidate, and proposed species, BLM sensitive species, and other state-managed wildlife species within the project area. For threatened and endangered species, project developers will also providing an official species from IPaC to the BLM.

- **ER-C-7sss** If a proposed project overlaps a species of concern (i.e., ESA threatened, endangered, candidate, proposed species) identified through IPaC.and state resource agencies If the USFWS, NMFS, or state resource agencies have resource concerns on the site-specific level, the BLM will request the agencies share maps and any updates and describe resource concerns.
- **ER-C-8sss** Project developers shall, to the maximum extent practicable, site project facilities and activities, including associated roads and utility corridors, out of occupied habitats, and corridors (e.g., migratory, habitat connectivity) of special status species.
- **ER-C-9sss** Project developers shall develop and implement measures to mitigate (e.g., avoid, minimize, compensate) impacts to candidate and petitioned species and their habitats when siting projects.
- **ER-C-10sss** Project developers shall conduct pre-construction surveys by qualified biologists, utilizing approved survey techniques or established species-specific survey protocols or a habitat assessment to determine the presence of SSS in the project area. If approved or established protocol surveys do not exist for a particular SSS, the presence of suitable habitat will be used as a surrogate for species presence. Surveys must be completed during the appropriate time of year following established protocols and shall be conducted by qualified and trained biologists. Work with BLM biologist, state wildlife agencies, and USFWS to obtain survey protocols and required state and Federal permits and to ensure current threatened, endangered, and SSS lists are used, identify survey needs, obtain survey protocols, and obtain required state and Federal permits.
- **ER-C-11sss** Project developers shall conduct suitable habitat and clearance surveys using qualified biologists as per USFWS survey protocols with a buffer for threatened and endangered and BLM sensitive plants species. The species-specific buffer shall be determined by the BLM for sensitive plants species and in coordination with the USFWS for T&E species.
- **ER-C-12sss** Project developers shall avoid direct disturbance of all occupied habitat for threatened, endangered, and proposed plant species, including implementation of appropriate avoidance areas established with the local BLM, USFWS, and state management agencies to the maximum extent practicable. Avoidance areas shall consider pollinator habitat and habitat connectivity. Occupied habitat will be flagged and avoided.
- **ER-C-13sss** When appropriate and only where avoidance and minimization is not feasible, and as a last option, project developers will work with BLM in coordination with appropriate federal (e.g., USFWS) and state agencies to determine if translocation would benefit the impacted SSS. If the agencies and

BLM agree that translocation is the preferred option, then a translocation plan will be developed, including steps to implement the translocation and follow-up monitoring and adaptive management of populations in the receptor locations. Mitigation of lost habitat will also be required in addition to the translocation effort and will be determined in coordination (and included as part of the BLM proposed action conservation commitments through section 7(a)(2) consultation for listed species) with appropriate federal and state agencies.

- **ER-C-14sss** Project developers shall ensure project design demonstrates neutral or beneficial long-term hydrologic effects to federally listed fish and amphibian species and the adjoining riparian and wetland habitat during project planning and prior to seeking authorization.
- **ER-C-15sss** Project developers shall demonstrate through hydrologic modeling that water withdrawals required for the project are not going to adversely affect the availability of groundwater for wildlife communities, special status species, their habitats, and sensitive plant communities. These modeling efforts need to consider potential adverse effects on immediate local resources and those that may be remote from the site both in time and place.
- **ER-C-16sss** Project developers shall develop aquatic resource buffers or setbacks that are effective for avoiding and minimizing impacts on federally listed fish, amphibians, and riparian birds during pre-construction, construction, decommissioning, and other project activities.
- **ER-C-17sss** Project developers shall avoid surface water or groundwater withdrawals or discharges that adversely affect sensitive habitats (e.g., aquatic, wetland, playa, microphyll woodland, and riparian habitats) and habitats occupied by SSS. Mitigation is required for any unavoidable losses. Mitigation measures may include changes to pumping rates, volume, or timing of water withdrawals; coordinating and scheduling groundwater pumping activities in conjunction with other users in the basin; acquisition of project water from outside the basin; and/or replenishing the groundwater resource over a reasonably short timeframe. If pumps are used for water withdrawals, the intakes must be fitted with a 1/8-inch screen, and the velocity at the intake screen cannot exceed 0.5 ft/s to avoid impingement of young life stages of aquatic species, including special status species.
- **ER-C-18sss** Project developers shall retain natural shelter sites whenever possible, such as boulder piles and burrows that may be used by tortoises for sheltering. If natural burrow sites must be removed, developer shall replace them with artificial burrows after construction in areas that would not interfere with production or maintenance. Consult with BLM and USFWS biologists to determine best location and design.
- **ER-C-19sss** If a proposed solar project has the potential to impact the northern long-eared bat *(Myotis septentrionalis) or other Federally-listed or other BLM special status species,* the project developer shall conduct surveys to determine bat use of the area during the spring, summer, and fall months. At a minimum,

the developer shall conduct acoustic surveys using bat detectors throughout the project area, but additional surveys in adjacent habitats may be necessary based on habitat or other information. Survey plans for listed or other BLM special status bat species shall be completed as recommended by the USFWS and/or state wildlife agencies, and must be approved by the local Ecological Services Field Office. Survey protocols are available and will be followed for the Service's Range-wide Indiana Bat and Northern Long-eared Bat Survey Guidelines (https://www.fws.gov/media/range-wide-indiana-bat-and-northern-long-eared-bat-survey-guidelines). Survey information shall be used in coordination with the USFWS and state wildlife agencies to develop and implement mitigation measures (i.e., avoidance, minimization, compensation) and proactive conservation measures.

- **ER-C-20sss** Project developers shall have acoustic surveys for SSS bats conducted to document pre-project bat activity and provide information for the development and implementation of mitigation measures (i.e., avoidance, minimization, compensation) and proactive conservation measures. See also ER-C-16w.
- **ER-C-21sss** Project developers shall exclude all solar development activities within the range map areas for endangered Mexican long-nosed bat (*Leptonycteris nivalis*) (https://ecos.fws.gov/ecp/species/8203).
- **ER-C-22sss** Project developers shall incorporate relevant conservation measures from the USFWS and NMFS recovery plans for threatened and endangered species, specifically conservation measures and proactive recovery actions for energy-related development.
- **ER-S&C-23sss** Project developers shall incorporate relevant conservation measures from the 2015 Greater sage-grouse amended resource management plans and the 2016 Bi-State Greater Sage-grouse resource management plan amendment.
- **ER-S&C-24sss** Transmission lines shall not be constructed over sensitive GRSG habitats such as leks and nesting areas.
- **ER-C-25sss** Project developers shall avoid loud noise-generating activities during breeding and nesting seasons based on species-specific information (e.g., >69 dBA for Mexican spotted owls (USFWS 2012)) and/or employing noise reduction devices (e.g., mufflers) to minimize the impacts on wildlife and SSS populations.
- **ER-C-26sss** Project developers shall, to the maximum extent possible, avoid/prevent siting projects, including ancillary facilities, in grizzly bear Recovery Zones (Primary Conservation Areas), grizzly bear Management Zone 1 and Demographic Monitoring Areas as defined in interagency grizzly bear ecosystem conservation strategies, and black-footed ferret reintroduction areas.
- **ER-C-27sss** Across the range of the grizzly bear or where the species occurs, during construction (and based on coordination with FWS), project personnel must:

  - 1) Follow Interagency Grizzly Bear Committee attractant storage requirements (igbconline.org) or as required by BLM Field Office or Statewide Order.
  - 2) Promptly clean up any project-related spills, litter, garbage, debris, etc.
  - 3) Store all food, food-related items, petroleum products, antifreeze, garbage, and personal hygiene items inside a closed, hard-sided vehicle or commercially manufactured bear-resistant container to make it unavailable to bears.
  - 4) Remove garbage from the project site daily and dispose of it in accordance with all applicable regulations.
  - 5) Receive appropriate avoidance/safety training when working in areas where they might encounter large species, such as grizzly bears.
  - 6) Carry bear spray (all individuals, including contractors, working alone or by at least two individuals when working in a group).
  - 7) Coordinate with FWS to determine necessary timing restrictions in grizzly bear seasonal spring and summer range and denning habitat.
  - 8) Notify the FWS Grizzly Bear Recovery Office of any grizzly bear/human conflicts within 24 hours after they occur. Conflict is any interaction between humans and bears in which they were surprised, attacked, charged, deployed bear spray, or defended themselves in any way, and/or conflict where a grizzly bear is expected to have received a reward from an attractant (e.g. food, animal carcass (including livestock), grills, stoves, dirty pots and pans, bird feeders, garbage), or any other suspected occurrence where a bear could associate activities with an attractant. See also ER-G-17sss.
  - See also ER-O-27sss.

- **ER-C-28sss** Project developers shall check with appropriate sources to determine whether or not listed fish are present or likely to be present during any proposed in-water work. The following work timeframes will be adhered to minimize impacts to bull trout and pallid sturgeon, where present:
  - Bull trout: In rivers and streams, foraging, migrating, and overwintering habitat in-channel disturbance is limited to the period between July 1 and September 30, except for projects incorporating dormant woody vegetation where species presence has been adequately evaluated; Spawning and rearing habitat in-channel disturbance is limited to the period between May 1 and August 31.
  - Pallid sturgeon: No in-channel work shall occur from May 15 – July 15 to protect spawning pallid sturgeon and developing and drifting larvae.
- **ER-C-29sss** No fumigant, treated bait, or other means of poisoning nuisance animals including rodenticides will be used in areas where BLM SSS occur.

- **ER-C-30sss** Project developers shall, as appropriate and in coordination with BLM, USFWS, and UDWR, use design features as necessary to prevent Utah prairie dog occupancy in portions of solar development sites where the animals can destroy wiring or other development components. However, portions of solar facilities shall be considered and left available for prairie dog use where appropriate.

B.4.2.5.1 Design features specifically for the Mojave Desert Tortoise (*Gopherus agassizii*)

These design features apply to any solar development applications within modeled desert tortoise habitat with a suitability index equal to or greater than 0.5 (Nussear et al. 2009 or most recent as approved by permitting agencies) or habitat supporting 5 or more tortoises per square mile (number of tortoises is based on estimates derived from the U.S. Fish and Wildlife Service's (USFWS) pre-project survey protocol (USFWS 2019 or most recent)). The goal of these design features is to retain as much vegetation cover, habitat suitability and access as possible within and across the project area post-construction.

- **ER-C-1dt** Minimize security fencing to the extent feasible.
- **ER-C-2dt** Limit fence and road construction to within the perimeter fence to reduce impacts to vegetation outside the project perimeter. Installation of both desert tortoise fencing and security fencing would occur along the interior perimeter road of the facility. All construction and soil spoils from fence installation would be maintained on the inside of the perimeter fence along the permanent interior perimeter road.
- **ER-C-3dt 3dt** Exclusion of tortoises from solar facilities shall be avoided whenever feasible – this is the preferred option to support recovery of the species and shall be coordinated with BLM and USFWS. If tortoise exclusion is not necessary, project developers will raise all project fences by 8 inches to allow for desert tortoise and wildlife movement through and/or between projects (subject to desert tortoise or other sensitive species provisions).
- **ER-C-4dt** If tortoise exclusion is necessary, as determined only after coordination with BLM and USFWS, project developers will ensure access for other wildlife through the fence by adding wildlife access gaps. Raised fences are preferable to fence gaps when habitat is deemed suitable to minimize wildlife pacing as much as possible. Alternatively, wildlife-friendly/permeable fencing with wider-spaced chain link could be used to allow for wildlife access without the use of fence gaps (see Making Solar Wildlife-Friendly | The Nature Conservancy).
- **ER-C-5dt** Record landscape and habitat conditions prior to disturbance using unmanned aerial vehicle (UAV) systems throughout the entire project area in order to understand the contour of the landscape (hydrological features), vegetation structure (diversity and density of perennial plants), and other existing features or habitat disturbances (e.g., evidence of previous wildfire, roads). A

permanent record of habitat conditions prior to ground disturbances will better inform habitat restoration needs at the end of the project lease and cumulative impacts to ecological resources from solar energy development. Incorporate this record into the Decommissioning and Site Reclamation Plan.

- **ER-C-6dt** Scraping, grading, and leveling of the project area (including disc and roll, drive and crush) of the project's developable area must be minimized and limited to designated main access roads, substations, operations and maintenance facilities, temporary laydown areas, and equipment pads. Project developer will work with BLM in coordination with USFWS to ensure scraping, grading, and leveling is minimized with a recommended goal of <20 percent to ensure retention of suitable desert tortoise habitat.
- **ER-C-7dt** Within areas impacted by the solar arrays, retain the agency-approved percentage of native vegetation cover (see vegetation Design Features in Section B.4.2.2). Within each block of panel arrays, topography, soils, and vegetation would be left in place, and installation of solar array components would occur over existing soils and vegetative resources. If this threshold is not met once construction is complete, restoration will be implemented until this goal is met per an approved site-specific Decommissioning and Site Restoration Plan (i.e., that 75 percent of vegetation cover of pre-construction vegetation is intact if 75 percent is the approved percentage of vegetative cover).
- **ER-C-8dt** Develop and approve a plan for evaluating impacts, monitoring, and adaptively managing vegetation throughout construction to ensure habitat impact thresholds have not been surpassed. Protocols would be developed to inventory the percentage of vegetation crushed during construction based on the habitat impact definitions provided above and would be outlined in the Decommissioning and Site Restoration Plan.
- **ER-C-9dt** Avoid all site-wide preparation practices, such as site-wide mowing and dozer soil compression, to reduce impacts. Mowing or trimming would be used in select situations when necessary.
- **ER-C-10dt** The Traffic Management Plan shall minimize vehicular activities during construction, operation and decommissioning phases to minimize impacts to vegetation by outlining access roads within panel arrays, proposed access routes, and drive and crush routes so that projects meet habitat impact thresholds (see Design Feature T-G-2). Route specifications would include movement patterns throughout the arrays, number of vehicle passes between each panel row, and types of vehicles planned for each step of panel construction. Routes should consider delivery and installation of truss posts, installation of racking, and delivery and installation of panels.
- **ER-C-11dt** Limit vehicle trips between panel arrays as much as possible once construction is complete. Vehicle trips would be limited to the established access roads and would be discontinued in vegetated areas to promote regrowth of existing vegetation and restoration efforts.

- **ER-C-12dt** Project developers, shall, to the extent practicable, upgrade or maintain crossings along existing facilities (e.g., roads, railroads, and aqueducts) such that desert tortoise occupancy and connectivity are not compromised.
- **ER-C-13dt** Project developers shall work with BLM and USFWS to incorporate measures to exclude tortoises from entering solar energy development sites during periods of active construction. Examples include, but are not limited to, tortoise-proof fencing (fence specifications shall be consistent with those approved by the USFWS in the Desert Tortoise Field Manual [USFWS 2009]). Tortoise turn arounds/tortoise fence end turnbacks will be installed at all road access points where desert tortoise-proof fencing is interrupted.
- **ER-C-14dt** During operations, BLM shall consult with FWS, on a case-by-case basis, on the appropriateness of considering allowing tortoises to reoccupy project sites. This evaluation shall consider the density of tortoises in the area and potential recipient translocation sites, connectivity, distance from existing infrastructure, etc. BLM and FWS shall determine if allowing tortoises to reenter the project site is preferable given the site conditions. Where tortoise reoccupancy is considered, a minimum vegetation cover standard shall be developed by BLM and FWS and maintained by the project developer. A minimum of 75% of reference site cover is the minimum cover standard that shall be considered for sites considering tortoise reoccupancy. If authorized, tortoises shall be allowed to access and move through the sites through fence modifications (e.g., fences should be raised 8 inches to allow desert tortoise and other wildlife movement).
- **ER-C-15dt** For desert tortoise, 1) Project developers shall prohibit grading, disc and roll, and other development techniques that disturb soil and completely remove vegetation in desert tortoise habitat, 2) require native/desirable vegetation of pre-disturbance in each solar panel array block be restored as soon as construction is complete per an approved site-specific Restoration Plan; 3) require Access Management Planning to describe access within the panel blocks.
- **ER-C-16dt** Project developers shall require that any unavoidable impacts to tortoises are mitigated by securing (acquiring, restoring, etc.) habitat outside of the project footprint but in the affected environment. Consultation with FWS is required to develop appropriate mitigation scenarios and ratios for unavoidable impacts.
- **ER-C-17dt** As part of the threatened and endangered species protection plan, project developers shall develop an overall desert tortoise conservation management action plan and mitigation framework, and proactive conservation/ recovery actions.

B.4.3 Operations and Maintenance

B.4.3.1 General Habitat Design Features

- **ER-O-1g** Project operators shall develop a plan of operations in consultation with the BLM and appropriate federal, state, and local agencies, to manage projects and to minimize impacts on ecological resources during operations and maintenance of the project, employing an adaptive management strategy and modifications, as necessary and approved by the BLM.

B.4.3.2 Design features specifically for Vegetation (v)

- **ER-O-1v** Project operators shall manage vegetation utilizing the principles of integrated pest management, including biological controls to prevent the spread of invasive species (BLM 2007; 2009; 2016), and maintain consultation with the BLM throughout operations and maintenance of the project, employing an adaptive management strategy and modifications, as necessary and approved by the BLM.
- **ER-O-2v** Project operators shall focus revegetation efforts on the establishment of native plant communities similar to those present in the vicinity of the project site (e.g., species diversity, composition, structure, % canopy cover, % bare soils).
- **ER-O-3v** Project operators shall, to the extent required based on the height of the solar panels, retain short (e.g., less than 18 in [46 cm] tall) native species during maintenance and operation activities.
- **ER-O-4v** Project operators shall monitor for and measure for success of native plantings, including factors such as species diversity, composition, structure, % canopy cover, % bare soils.
- **ER-O-5v** Project operators shall educate project personnel on noxious weed identification, the manner in which noxious weeds spread, and methods for treating infestations.
- **ER-O-6v** Project operators shall periodically monitor, report on, and immediately eradicate noxious weed or invasive species within all managed areas.
- **ER-O-7v** Project operators shall perform maintenance mechanically rather than with herbicides to the extent practicable.
- **ER-O-8v** Project operators shall monitor and/or mitigate the effects of groundwater withdrawals on plant communities.
- **ER-O-9g** The project operators shall maximize area reclaimed during solar energy operations to minimize habitat loss and fragmentation.

B.4.3.3 Design features specifically for Aquatic Habitat (aq)

- **ER-O-1aq** To reduce risk of non-native and nuisance aquatic species introductions, project operators shall decontaminate equipment used in surface

water, especially equipment used to convey water (i.e., pumps). Ensure source water would not introduce new aquatic invasive species or contaminants.

- **ER-O-2aq** Project operators shall minimize removal of deadfall or overhanging vegetation in streams for crossings.
- **ER-O-3aq** Project operators shall install fish screens on surface water withdrawal intakes (where used) to limit the potential for impingement and entrainment impacts on organisms in surface water sources used.

B.4.3.4 Design features specifically for Wildlife (w)

- **ER-O-1w** Project operators shall plan for and develop measures that identify management practices to avoid, minimize, and/or mitigate increases in nuisance animals and pests in the project area. The plans shall identify nuisance and pest species that are likely to occur in the area, risks associated with these species, species-specific control measures, and monitoring requirements.
- **ER-O-2w** Project operators shall instruct personnel to avoid harassment and disturbance of local plants, wildlife, and wildlife habitat, and ensure personnel understand the applicable state and Federal laws respective to wildlife harassment.
- **ER-O-3w** Project operators shall inform personnel of the potential for wildlife interactions around facility structures.
- **ER-O-4w** Project operators shall keep lighting at both operation and maintenance facilities and substations to the minimum required.
- **ER-O-5w** Project operators shall use lights with motion or heat sensors and switches to keep lights off when not required.
- **ER-O-6w** Project operators shall minimize use of high-intensity lighting, steady-burning, or bright lights such as sodium vapor, quartz, halogen, or other bright spotlights.
- **ER-O-7w** Project operators shall minimize the use of lights and, where necessary, consider the use of red or other colored lights to minimize distractions to animals (i.e., bats, pollinators).
- **ER-O-8w** Project operators shall outfit support wires, shield wires, powerlines, etc., with markers and reflectors to minimize collisions of birds, bats, and other wildlife. Ideally these would include LED diverters to reduce attraction of nighttime migrants.
- **ER-O-9w** Project operators shall turn off all unnecessary lighting at night, direct the lighting downward, and away from riparian areas and wetlands to limit attracting wildlife, particularly migratory birds and bats.
- **ER-O-10w** Project operators shall tilt the arrays upward where feasible to minimize moon-glare (and a bat/bird collision threat) from the panels.

- **ER-O-11w** Project operators shall monitor for, report, and use adaptive management to minimize or mitigate raptor and other bird mortality associated with solar projects (e.g., collisions with panels and power lines), educate workers on the laws that protect raptors, and educate workers to report any incidences of illegal shooting of raptors.
- **ER-O-12w** Project operators shall remove raptor nests (excluding eagles) only if the birds are not actively using the nest, only if necessary for facility operation, and only after coordination with BLM, USFWS, and state wildlife agencies.
- **ER-O-13w** Project operators shall coordinate with BLM, USFWS, and state wildlife agencies if relocation of nests to nesting platforms is necessary and appropriate. Relocating birds or bird nests containing eggs or chicks requires a permit from USFWS Migratory Bird program and must be conducted by qualified biologists. The use of nest buffers (seasonal and/or spatial buffers) as part of the Nesting Bird Management Plan will protect nests with eggs or chicks until the young fledge the nest. Report relocated or destroyed nests to the appropriate federal and/or state agencies.
- **ER-O-14w** Project operators shall avoid the addition of wildlife habitat enhancements or improvements such as ponds, guzzlers, rock or brush piles for small mammals, bird nest boxes, nesting platforms, and wildlife food plots that increase wildlife use of the facility, which may result in increased levels of injury or mortality.
- **ER-O-15w** Project operators shall coordinate with the USFWS and BLM project personnel in the event that a raptor nest is located on a transmission line support structure.
- **ER-O-16w** Project operators shall avoid, to the extent practicable, the use of guy wires to minimize impacts on birds and bats.
- **ER-O-17w** Project operators shall place mechanisms to visually warn birds (permanent markers or bird flight diverters) on transmission lines, guy wires, shield wires, and fences at regular intervals sufficient to prevent birds from colliding with the lines.
- **ER-O-18w** Project operators shall add anti-glare films or anti-bird collision film to the panels to reduce bird and bat collisions, for projects where glare has been found to have substantial adverse impacts.
- **ER-O-19w** Project operators shall monitor for and use adaptive management to minimize or mitigate bird mortalities (e.g., raptors, migratory birds) associated with the solar project, in coordination with BLM and USFWS. Mortalities shall be reported to the BLM and the USFWS.
- **ER-O-20w** Project operators shall monitor for and use adaptive management to minimize or mitigate bat mortalities associated with the solar project. Mortalities shall be reported to the BLM and the USFWS, if required.
- **ER-O-21w** Project operators shall coordinate with the USFWS and BLM project personnel in the event that a raptor nest is located within the project area.

B.4.3.5 Design features specifically Special Status Species (sss)

- **ER-O-1sss** Project operators shall monitor and adaptively manage special status species and habitat to avoid and minimize impacts, and ensure effective restoration.
- **ER-O-2sss** Project operators shall remove raven nests in desert tortoise habitat only when inactive (i.e., no eggs or young). The removal of raven nests may be addressed in the most current USFWS guidance (e.g., FONSI, *Implementation of a Desert Tortoise Recovery Plan Task: Reduce Common Raven Predation on the Desert Tortoise*, *2008*).
- **ER-O-3sss** Project developers shall use adaptive management and mitigation in areas with high raven occurrence.
- **ER-O-4sss** Project operators shall develop and implement a Desert Tortoise Habitat Management Plan, Desert Tortoise Habitat Linkage Management and Monitoring Plan and a Desert Tortoise Population Connectivity Effectiveness-Monitoring Plan for projects that affect desert tortoise linkages, as described in the USFWS Biological Opinion and Conservation Review for the Solar Energy Program (July 20, 2012).
- **ER-O-5sss** Project operators shall monitor for increase in predation of SSS from predators that are attracted to developed areas, and use adaptive management, agreed upon in coordination with the BLM and if applicable, the USFWS, to reduce predation.
- **ER-O-6sss** Within the range of the California condor (foraging, roosting areas, etc.), project operators shall control and dispose of all litter, trash, and debris that might be generated during the project operations. Specific care shall especially be taken to dispose of small trash such as bottle caps, aluminum can tabs, and other small plastic, glass, or metal trash debris that potentially serve as an attractant, particularly during chick-rearing seasons.
- **ER-O-7sss** There shall be no helicopter installation activities within 4 miles of GRSG leks in the spring time prior to 10 am**.**
- **ER-O-8sss** Across the range of the grizzly bear or where the species occurs, during operations (and based on coordination with FWS), project personnel must follow the same requirements specified for construction under design feature ER-C-27sss. See also ER-G-17sss.

B.4.4 Decommissioning and Reclamation

B.4.4.1 General Habitat Design Features

- **ER-D-1g** Prior to development, the project operators shall develop a Decommissioning and Site Reclamation Plan that, at minimum: 1) specifies the methods, timing (e.g., criteria for triggering closure and decommissioning actions), and criteria for success (including quantifiable and measurable criteria), 2) re-contours areas that were substantially altered from their original contour

or gradient and installing erosion control measures in disturbed areas where potential for erosion exists, 3) restores native vegetation communities as well as soil profiles to pre-disturbance conditions and functions that will support and maintain native plant communities, associated carbon sequestration and nutrient cycling processes, and native wildlife species, and 4) identifies vegetation restoration actions and criteria that will identify and use native vegetation composition, native seed composition, and diversity standards. See also ER-G-2v, ER-C-3v, ER-D-1v, ER-D-2v, GS-C-31, and GS-D-3.

- **ER-D-2g** The project operators shall conduct interim and final restoration activities as soon as possible after development activities are completed in order to reduce the amount of habitat converted at any one time and to speed up the restoration to natural habitats.
- **ER-D-3g** The project operators shall close and restore access roads when they are no longer needed, considering seasonal restrictions. Restoring these roadbeds to native vegetation and topography, consistent with landowner agreements.
- **ER-D-4g** The project operators shall develop and implement monitoring measures to ensure successful restoration per the Decommissioning and Site Reclamation Plan. If objectives are not being met, operators shall identify and implement new measures to ensure success.
- **ER-D- 5g** The project operators shall fill or grade holes and ruts created by the removal of structures and access roads.
- **ER-D-6g** The project operators shall maintain a clean and orderly worksite during and after decommissioning to ensure land is clear of debris.
- **ER-D-7g** The project operators shall remove foundations to a minimum of three ft below surrounding grade, and cover with soil to allow adequate root penetration for native plants, and so that subsurface structures do not substantially disrupt ground water movements.
- **ER-D-8g** The project operators shall compensate for residual effects using ratios based on the resource being impacted. The compensation shall allow for restoration of BLM degraded lands, land acquisition, or a combination depending on the resource being impacted. The need to maintain, restore, and protect habitat connectivity must be considered in compensation proposals.

B.4.4.2 Design Features for Vegetation (v)

- **ER-D-1v** The project operators shall coordinate with the BLM to use certified weed-free seed mixes or propagules of native, geographically appropriate shrubs, grasses, and forbs, as required in the Decommissioning and Site Reclamation Plan. Locally sourced seed mixes (from within appropriate seed transfer zones) shall be used where available. Seed mixes shall be developed in coordination with appropriate agencies (e.g., BLM, USFWS, and state resource management

agencies) taking into account the impacted wildlife habitat types and native plant communities. See also ER-G-2v, ER-C-3v, ER-D-1g, ER-D-2v, GS-C-31, and GS-D-3.

- **ER-D-2v** The project operators shall lightly rake, rip, drill, and or aerially apply and reseed disturbed areas with geographically appropriate native seeds as available. See also ER-G-2v, ER-C-3v, ER-D-1g, ER-D-1v, GS-C-31, and GS-D-3.
- **ER-D-3v** The project operators shall continue vegetation reestablishment efforts until all success criteria have been met, as identified within the Decommissioning and Site Reclamation Plan.
- **ER-D-4v** The project operators shall conduct Cactus Salvage in conformance with BLM policy, including using salvaged or nursery stock yuccas (all species), and cacti (excluding cholla species, genus *Cylindropuntia*, except those that are designated as BLM special status species or as necessary to retain *Cylindropuntia* to protect other cacti), in revegetation plans and implementation affecting BLM lands.
- **ER-D-5v** The project operators shall stockpile topsoil removed during decommissioning and replace it to the site when restoring plant communities. Once decommissioning activity is complete, topsoil shall be restored to assist in establishing and maintaining pre-construction native plant communities to the extent possible, consistent with landowner objectives.

B.4.4.3 Design Features for Aquatic Habitat (aq)

- **ER-D-1aq** The project operators shall restore surface water flows to pre-disturbance conditions, including removal of stream crossings, roads, and pads, consistent with storm water management objectives and requirements. Within the first planting season post-construction, any stabilized stream banks shall be revegetated with native or other approved species.
- **ER-D-2aq** After decommissioning, project operators shall install erosion control measures in all disturbance areas where potential for erosion exists, consistent with storm water management objectives and requirements.
- **ER-D-3aq** The project operators shall remediate any petroleum product leaks and chemical releases prior to completion of decommissioning.

B.4.4.4 Design Features for Special Status Species (sss)

- **ER-D-1sss** The project operators shall conduct post construction monitoring for special status plant and animal species for a minimum of five years post-construction. Monitoring shall focus on impacts to special status species, including but not limited to impacts to wildlife movements and increased mortality. The causes of impacts and adaptive management to resolve the impacts to the extent feasible will be addressed during the post construction monitoring period (i.e., is the solar field the cause of mortality and how can this be limited?).

- **ER-D-2sss** The project operators shall leave the facility fencing in place for several years or replace it with new exclusion fencing to assist reclamation and restoration efforts (e.g., the fence could preclude large mammals and vehicles from disturbing revegetation efforts). Shorter times for maintaining fencing may be appropriate in cases where the likelihood of disturbance by cattle and wildlife is low. Design features relevant to allowing wildlife and desert tortoise access to solar facilities will be maintained in any remaining facility fencing.
- **ER-D-3sss** The project operators shall remove fencing and overhead pole lines that are no longer needed.

B.5 Design Features for Environmental Justice (EJ)

The following general design features have been identified to avoid, minimize, and/or mitigate potential disproportionate and adverse impacts from utility-scale solar development on BLM-administered lands, with respect to communities with environmental justice concerns. This mitigation process is dependent on inclusive, meaningful involvement with, and equitable and just outcomes for, affected minority, low-income, and Tribal communities. These design features shall be further assessed and evaluated by project developers, in coordination with the BLM, county authorities, Tribal governments, and other qualified experts[3] as part of a project-specific environmental impact analysis, to identify discrete and/or cumulative socioeconomic, public health, socio-cultural, and environmental conditions that disproportionately and adversely affect low-income, minority, and Tribal populations, and to develop strategies to equitably address those conditions.

The following design features are included to identify and/or mitigate disproportionate and adverse impacts during all phases of solar energy site development, but may be supplemented with additional BLM-required mitigation measures during project-specific evaluations (e.g., additional or alternative methods and solutions may be identified during project-specific consultation with local minority, low-income, and Tribal communities who may be disproportionately and adversely impacted by project-related decisions and actions).

B.5.1 General

The BLM and project developers shall coordinate early in the project planning process to identify and minimize impacts on environmental justice communities of concern, by:

- **EJ-G-1** The BLM and project developers shall provide accessible, relevant information to be delivered to potentially affected low-income, minority, and Tribal communities and local governments. The data analysis shall include the initial screening included in this PEIS as well as a more focused analysis of local

[3] Recognize that qualified experts include minority, low-income, and Tribal community members who will be affected by project decisions and outcomes.

demographics and locally relevant cumulative and potential project-related beneficial and adverse impacts.

- **EJ-G-2** The BLM and project developers shall provide information on the likely impact of a utility-scale solar project on air quality, water quality, and land resources, and the relevant design features for these resources that would be required under the ROD for this Solar Programmatic EIS.
- **EJ-G-3** The BLM and project developers shall provide information on the scale and timeline of expected solar projects.
- **EJ-G-4** The BLM and project developers shall create equitable and accessible opportunities for meaningful involvement by initiating and maintaining contact with communities with environmental justice concerns.
- **EJ-G-5** The BLM and project developers shall make technical, physical, or other accommodations, as needed, to facilitate participation with underserved communities.
- **EJ-G-6** The BLM and project developers shall offer multiple, accessible avenues to provide public comment.
- **EJ-G-7** The BLM and project developers shall reach out via organizations and partner agencies that are trusted in the communities (OMB 2021).
- **EJ-G-8** The BLM and project developers shall develop and apply community benefit agreements or good neighbor agreements, if appropriate.
- **EJ-G-9** The BLM and project developers shall avoid siting solar projects in areas where impacts on environmental justice concerns, or impacts on human health and welfare generally, are reasonably foreseeable. Such impacts include but are not limited to air quality, drinking water supplies, subsistence resources, and public services.
- **EJ-G-10** The BLM and project developers shall immediately address any identified impacts on environmental justice concerns, or an impact on human health or safety generally, in coordination with the local governments.
- **EJ-G-11** The BLM and project developers shall prioritize local minority, low-income, and Tribal populations for project-related employment opportunities, wherever feasible; and establish vocational training programs for local schools and the local low-income and minority workforce to promote development of skills for, equitable apprenticeship, and high-quality employment opportunities within the solar energy industry (local projects, if possible). The BLM and project developers shall consider options to include labor standards, workforce agreements, and local hiring provisions for clean energy projects.
- **EJ-G-12** The BLM and project developers shall follow up with minority and low-income communities periodically during the 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. Schedule ongoing

reporting and coordination meetings with county government officials to identify and resolve emergent issues.

B.5.2 Site Characterization, Siting and Design, and Construction

- **EJ-C-1** The project developer shall support environmentally-just mining practices through responsible procurement. This would involve applying selection criteria for obtaining mineral resources and manufactured products from companies that prioritize ethical and ecologically sound mineral extraction and manufacturing practices (see OECD 2016, 2023 in 5.5.6 References for guidance on how to do this).

B.5.3 Operations and Maintenance

- **EJ-O-1** The project owner/operators shall continue to prioritize local minority, low-income, and Tribal populations for project-related employment opportunities, wherever feasible, by continuing support for the establishment of vocational training programs for local schools and the local low-income and minority workforce to promote development of skills for, and equitable employment opportunities within, the solar energy industry (local projects, if possible).

B.5.4 Decommissioning/Reclamation

- **EJ-D-1** The project owner/operators shall provide accessible communication outreach and engagement with affected minority, low-income, and Tribal communities with environmental justice concerns about potential post-project social, economic, or health-related impacts that they may experience due to changes in land use and decommissioning of utility-scale solar operations.
- **EJ-D-2** The project owner/operators and the BLM shall consider the needs and desires of low-income, minority, and Tribal populations in determining the specific conditions to which the land will be reclaimed.

B.6 Design Features for Geology and Soil Resources (GS)

The following design features have been identified to avoid, minimize, and/or mitigate potential soil impacts and potential geologic hazards from utility-scale solar energy development on BLM-administered lands.

B.6.1 General

Project developers shall coordinate with the BLM and other federal, Tribal, state, county, and local agencies early in the project planning process to assess soil erosion and geologic hazard concerns. Consultation with the BLM and applicable Tribal, state, and county agencies shall be maintained through the operations and maintenance of the project, employing an adaptive management strategy and modifications, as necessary and approved by the BLM.

General design features to avoid, minimize, and/or mitigate potential impacts include:

- **GS-G-1** The project developer shall identify soil erosion and geologic hazard concerns onsite and in proximity to the proposed projects. In coordination with the BLM, Tribal, state, county, and local agencies, developers shall consult existing land use plans, updated inventories, soil surveys, etc.
- **GS-G-2** The project developer shall identify local factors that can cause slope instability (e.g., groundwater conditions, precipitation, earthquake activity, slope angles, and the dip angles of geologic strata).
- **GS-G-3** The project developer shall consult with local federal, Tribal, state, and county agencies regarding road design on the basis of local meteorological conditions, soil moisture, and erosion potential.
- **GS-G-4** The project developer shall determine the potential safety and resource impacts associated with soil erosion, including potential fugitive dust impacts.
- **GS-G-5** The project developer shall evaluate soil erosion and geologic hazard concerns as part of the environmental impact analysis for the project and consider options to avoid, minimize, and/or mitigate adverse impacts in coordination with the BLM, Tribal, state, county, and local agencies.

B.6.2 Site Characterization, Siting and Design, Construction

- **GS-C-1** The project developer shall design structures to meet the requirements of all applicable federal, state, and county regulations, permits, and building codes to prevent and reduce soil erosion, including the development of a Stormwater Pollution Prevention Plan, if required.
- **GS-C-2** The project developer shall minimize ground-disturbing activities, including soil compaction, excavation, and vegetation removal. The footprint of disturbed areas, including the number and size/length of roads, fences, mineral materials sites (borrow areas), and laydown and staging areas, shall be minimized.
- **GS-C-3** The project developer shall use existing roads, disturbed areas, and mineral materials sites (borrow pits) before creating new infrastructure, and obtain mineral materials from authorized and permitted sites. The use of any existing infrastructure shall be analyzed in the environmental analysis for the proposed project.
- **GS-C-4** The project developer shall avoid areas with soils that are highly susceptible to wind or water erosion.
- **GS-C-5** The project developer shall avoid areas with existing biological soil crusts and desert pavement and other areas where reclamation may be difficult.
- **GS-C-6** The project developer shall identify construction zone boundaries on the ground (e.g., using construction fencing) to minimize conflict with other resource concerns, and avoid clearing and disturbing areas outside the construction zone.

- **GS-C-7** The project developer shall, where possible, bury electrical lines f along existing features (e.g., roads or other paths of disturbance) to minimize the overall area of surface disturbance.
- **GS-C-8** The project developer shall integrate the natural contours of the land into the design and configuration of the project to minimize land grading.
- **GS-C-9** The project developer shall conduct construction grading (where necessary) in compliance with industry practice (e.g., ASTM International standard methods) and other requirements (e.g., BLM, state, and local grading and/or construction stormwater permits).
- **GS-C-10** The project developer shall site, design, and construct new roads and walking trails consistent with the appropriate design standards and criteria, such as those described in BLM Manual 9113 (BLM 1985), BLM (2007), and 43 CFR 8342.1. Roads and trails shall follow natural land contours and avoid desert washes. Hill cuts shall be minimized in the project area.
- **GS-C-11** The project developer shall avoid excessive grades on roads, road embankments, ditches, and drainages during site preparation and construction, especially in areas with erodible soils.
- **GS-C-12** The project developer shall avoid the creation of excessive slopes during site preparation and construction (e.g., during excavation); use special construction techniques in areas of steep slopes, erodible soil, and drainage ways; and stabilize disturbed slopes as quickly as possible.
- **GS-C-13** The project developer shall minimize the land footprint for the foundations of vertical support structures to reduce soil compaction and vegetation removal.
- **GS-C-14** The project developer shall minimize land disturbance (including crossings) in natural drainage systems and groundwater recharge zones (i.e., ephemeral washes and dry lake beds).
- **GS-C-15** The project developer shall locate and construct drainage crossing structures so as not to decrease channel stability or increase water volume or velocity.
- **GS-C-16** The project developer shall provide adequate space (i.e., setbacks) between solar facilities and natural washes to preserve hydrologic function.
- **GS-C-17** The project developer shall control water runoff from the construction area and direct it to settling or rapid infiltration basins.
- **GS-C-18** The project developer shall retain sediment-laden waters from disturbed, active areas within the project using barriers and sedimentation devices (e.g., berms, straw bales, sandbags, jute netting, or silt fences). The project developer shall avoid use of such barriers and devices in wildlife crossing areas.
- **GS-C-19** The project developer shall prevent channel erosion from project runoff. Disconnection length between panels and the erosion potential of water

dripping from panels shall be considered in the site design to minimize erosion by water.

- **GS-C-20** The project developer shall control culvert outlets with appropriate structures (e.g., rock lining or apron) to reduce soil erosion and scouring.
- **GS-C-21** The project developer shall control project vehicle traffic and equipment speeds on unpaved surfaces to avoid and reduce soil compaction and fugitive dust emissions.
- **GS-C-22** The project developer shall use water or other stabilizing agents to wet unpaved roads in active construction areas, laydown areas, and other disturbed areas to minimize wind erosion of soil and fugitive dust emissions.
- **GS-C-23** The project developer shall implement construction in stages to limit the areas of exposed and unstabilized soils. For example, only land that will be actively under construction in the near term (e.g., within the next 6 to 12 months) shall be cleared of vegetation.
- **GS-C-24** The project developer shall reduce construction activity timeframes so that ground-disturbing activities take place over as short a timeframe as possible. If an activity requires an extended schedule, measures to limit wind and water erosion shall be employed during the activity (rather than after the activity), to the extent possible.
- **GS-C-25** The project developer shall use temporary stabilization devices (i.e., erosion matting blankets or soil stabilizing agents) for areas that are not actively under construction.
- **GS-C-26** The project developer shall use wind fencing where needed to reduce fugitive dust emissions.
- **GS-C-27** The project developer shall replant project areas with native vegetation at spaced intervals to break up areas of exposed soil and reduce soil loss by wind erosion.
- **GS-C-28** The project developer shall recontour and revegetate project roads that are no longer needed to increase infiltration and reduce soil compaction.
- **GS-C-29** The project developer shall stockpile and utilize originally excavated materials for backfill.
- **GS-C-30** The project developer shall salvage topsoil from all excavation and construction and reapply to disturbed areas upon completion of construction.
- **GS-C-31** The project developer shall restore native plant communities as quickly as possible in disturbed areas through natural revegetation or by seeding and transplanting (using certified weed-free native grasses, forbs, and shrubs where available), based on BLM recommendations. See also ER-G-2v, ER-C-3v, ER-D-1g, ER-D-1v, ER-D-2v, and GS-D-3.
- **GS-C-32** For cases in which impacts to biological soil crusts cannot be avoided, the project developer shall salvage and restore soil crusts, based on BLM recommendations, once construction has been completed.

- **GS-C-33** The project developer shall perform studies to determine the effects from construction activities on the eolian processes that maintain any nearby sand dunes, if applicable.
- **GS-C-34** The project developer shall incorporate environmental inspection and monitoring measures into the plan of development and other applicable plans to monitor and respond to impacts on soil resources during construction, operations, and decommissioning of a solar energy development, including adaptive management protocols.
- **GS-C-x** The project developer shall avoid areas with soils designated as prime or unique farmland, or farmland of statewide or local importance.
- **GS-C-35** The project developer shall design structures to meet the requirements of all applicable state and local building codes related to geologic hazards, including flood risk.
- **GS-C-36** The project developer shall conduct ground-disturbing geotechnical studies (e.g., geotechnical drilling) in adherence to the permitting requirements specified by the BLM in 43 CFR 2920.
- **GS-C-37** The project developer shall build project structures in accordance with the design-basis recommendations in the project-specific geotechnical investigation report.
- **GS-C-38** The project developer shall avoid areas with high seismic risks or unstable slopes.

B.6.3 Operations and Maintenance

- **GS-O-1** The project developer shall apply design features developed for the construction phase to similar activities during the operations phase.
- **GS-O-2** The project developer shall perform routine site inspections to assess the effectiveness of maintenance requirements for erosion and sediment control systems.
- **GS-O-3** The project developer shall consider alternatives to herbicides and mowing for vegetation control, such as use of low-growing native vegetation and livestock grazing.
- **GS-O-4** The project developer shall maintain permanent barriers and sedimentation devices to ensure effective control of runoff and soil erosion.
- **GS-O-5** The project developer shall maintain catch basins, roadway ditches, and culverts to ensure proper function.
- **GS-O-6** The project developer shall identify soil erosion and geologic hazard requirements within the plan of development and other applicable plans.
- **GS-O-7** The project developer shall ensure that permanent stabilization of disturbed areas occurs during final grading and landscaping of the site and is maintained through the life of the facility.

B.6.4 Decommissioning/Reclamation

- **GS-D-1** The project developer shall apply design features developed for the construction phase to similar activities during the decommissioning and reclamation phase.
- **GS-D-2** The project developer shall re-establish, to the extent possible, the original grade and drainage pattern.
- **GS-D-3** The project developer shall restore native plant communities in disturbed areas by natural revegetation or by seeding and transplanting (using certified weed-free native grasses, forbs, and shrubs where available), on the basis of recommendations by the BLM, once decommissioning is completed. See also ER-G-2v, ER-C-3v, ER-D-1g, ER-D-1v, ER-D-2v, and GS-C-31.

B.7 Design Features for Hazardous Materials and Waste (HMW)

The following design features have been identified to avoid, minimize, and/or mitigate impacts from hazardous materials and waste produced at utility-scale solar facilities on BLM-administered lands.

B.7.1 General

Project developers shall coordinate with the BLM and other federal, state, and local agencies early in the planning process to assess hazardous material and waste concerns and to minimize potential impacts. Consultation with the BLM shall be maintained through the operations and maintenance of the project, employing an adaptive management strategy and modifications, as necessary and approved by the BLM.

General design features to avoid, minimize, and/or mitigate potential impacts include:

- **HMW-G-1** Project developers shall identify expected waste generation streams at the solar energy site and hazardous waste storage locations for consideration in the environmental analysis evaluating the proposed project.
- **HMW-G-2** Project developers shall conduct site characterization, construction, operation, and decommissioning activities in compliance with applicable federal and state laws and regulations, including the Toxic Substances Control Act of 1976, as amended (15 USC 2601, et seq.) and Resource Conservation and Recovery Act (RCRA). An example of complying with applicable law is reporting any release of toxic substances (leaks, spills, etc.) in excess of the reportable quantity established by 40 CFR Part 117 as required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, Section 102b.
- **HMW-G-3** Project developers shall evaluate potential hazardous material and waste-related impacts as part of the environmental impact analysis for the

project and considering options to minimize and/or mitigate impacts in coordination with the BLM.

- **HMW-G-4** Project developers shall develop a Hazardous Materials and Waste Management Plan that addresses the selection, transport, storage, and use of all hazardous materials needed for construction, operation, and decommissioning of the facility for local emergency response and public safety authorities and for the designated BLM land manager. Furthermore, the plan shall address the characterization, onsite storage, recycling, and disposal of all resulting wastes.[4] At minimum, the plan will discuss:
    - Facility identification;
    - Comprehensive hazardous materials inventory;
    - Safety Data Sheets (SDSs) for each type of hazardous material;
    - Emergency contacts and mutual aid agreements, if any;
    - Site map showing all hazardous materials and waste storage and use locations;
    - Copies of spill and emergency response plans; and
    - Hazardous materials-related elements of a Decommissioning and Site Reclamation Plan.
    - During operations and at decommissioning, disposal of solar panels in landfills is prohibited unless the developer shown that no recycling facilities are available in the U.S. at that time.
- **HMW-G-5** Project developers shall ensure that all plans for and management of toxic and other waste materials consistent with federal, state, and local regulation under the Resource Conservation Recovery Act (42 U.S.C. 6929 et seq.).
- **HMW-G-6** Project developers shall plan for waste management that will address all solid and liquid wastes that may be generated at the site, in compliance with the CWA requirements to obtain the project's NPDES or similar permit.
- **HMW-G-7** Project developers shall plan for the handling, storage, application, or disposal of hazardous or toxic materials to prevent pollution to streams, lakes, or wetlands or that may damage or injure humans, land, animals, or plants. The plan will prohibit "side casting" of road or other material into a stream, lake, wetland, or watercourse; and the deposit of vegetative debris in streams, lakes, or other water bodies.

[4] It is not anticipated that any solar energy facility will have toxic and/or flammable substances identified under section 112(r) of the Clean Air Act present onsite in greater than threshold quantities (40 CFR Part 68 Subpart F § 68.130) as to require development of a Risk Management Plan as specified in 40 CFR Part 68.

- **HMW-G-8** Project developers shall ensure that all hazardous materials storage, use, and disposal is compliant with all applicable building codes and regulations (OSHA, RCRA, NFPA, TSCA, CERCLA, etc.).
- **HMW-G-9** Project developers shall identify and implement prevention measures, including material substitution of less hazardous alternatives.
- **HMW-G-10** Project developers shall identify and implement reduction measures, including recycling and waste minimization.
- **HMW-G-11** Project developers shall establish procedures for fuel storage and dispensing that comply with all applicable building codes and regulations (OSHA, RCRA, NFPA, TSCA, CERCLA, etc.).
- **HMW-G-12** Project developers shall develop and implement a Spill Prevention Control and Emergency Response Plan that includes monthly inspections of fuel, oil, or hazardous materials stored in containers that are 30 gallons or greater.
- **HMW-G-13** Project developers shall ensure vehicles and equipment are in proper working condition to reduce potential for leaks of motor oil, antifreeze, hydraulic fluid, grease, or other hazardous materials.
- **HMW-G-14** Project developers shall plan for responding to releases of hazardous materials by establishing schedules for regular removal of wastes (including sanitary wastewater generated in temporary, portable sanitary facilities) for delivery and removal by licensed haulers to appropriate offsite treatment or disposal facilities.

B.7.2 Site Characterization, Siting and Design, Construction

- **HMW-C-1** Project developers shall provide a copy of any report required or requested by any federal agency or state government as a result of a reportable release or spill of any toxic substances or petroleum, oils, or lubricant spills relevant to the Oil Pollution Act and Clean Water Act. Reports shall be furnished to the BLM-authorized officer concurrent with the filing of the reports to the involved federal agency or state government not more than five calendar days from the date of the release or when the release is first identified, whichever is earlier.
- **HMW-C-2** Project developers shall design and operate systems containing hazardous materials in a manner that limits the potential for their release (compliant with 29 and 40 CFR).
- **HMW-C-3** Project developers shall establish measures for construction and materials handling that comply with all applicable building codes and regulations (OSHA, RC RA, NFPA, TSCA, CERCLA, etc.)
- **HMW-C-4** Project developers shall establish dedicated areas with secondary containment for off-loading hazardous materials transport vehicles.
- **HMW-C-5** Project developers shall, where practical, implement “just-in-time” ordering procedures that are designed to limit the amounts of hazardous

materials present on the site to quantities minimally necessary to support continued operations. Excess hazardous materials shall be removed from the site within 48 hours of discovery or notice.

- **HMW-C-6** Project developers shall: establish schedules of regular removal of wastes (including sanitary wastewater generated in temporary, portable sanitary facilities) for delivery and removal by licensed haulers to appropriate offsite treatment or disposal facilities; identify toxic and other waste disposal facilities, including for decommissioned site materials, consistent with county planning and regulations for waste disposal; comply with a federal, state, and local regulations under the Resource Conservation Recovery Act (42 U.S.C. 6929 et seq.) for disposal of toxic and other waste materials; and plan for reporting and coordination with local government authorities on hazardous materials and waste disposal issues.
- **HMW-C-7** Project developers shall survey project sites for unexploded ordnance, especially if projects are within 20 mi (32 km) of a current Department of Defense (DoD) installation or formerly utilized defense site.
- **HMW-C-8** Project developers shall site refueling areas away from surface water locations and drainages and on paved surfaces; refueling operations on paved surfaces shall be sloped and bermed to contain any release as per EPA amended Spill Prevention, Control, and Countermeasure (SPCC) rule; and features shall be added to direct any spilled materials to sumps or safe storage areas where they can be subsequently recovered.
- **HMW-C-9** Project developers shall designate hazardous materials and waste storage areas and facilities, limiting access to designated areas to authorized personnel only.

B.7.3 Operations and Maintenance

- **HMW-O-1** Where applicable, project developers shall install sensors or other devices to monitor system integrity. Sensors and devices shall be purchased, deployed, and maintained by the project developer.
- **HMW-O-2** Project developers shall implement site inspection and repair procedures.
- **HMW-O-3** Project developers shall coordinate with local fire departments and emergency management departments to ensure that emergency service providers receive specialized training as needed.
- **HMW-O-4** Project developers shall ensure emergency responders are fully informed regarding the project's hazardous material risks and how to safely respond to fires at the facility if needed.

B.7.4 Decommissioning/Reclamation

- **HMW-D-1** Project developers shall recycle, to the greatest extent possible, all components of the system during the life of the system and at decommissioning, in compliance with solid and hazardous waste requirements. (Some states have enacted laws and regulations specific to the recycling and disposal of solar panels.)
- **HMW-D-2** Project developers shall maintain emergency response capabilities throughout the decommissioning and reclamation period as long as hazardous materials and wastes remain onsite.
- **HMW-D-3** All design features developed for the construction phase shall be applied to similar activities during the decommissioning and reclamation phases.

B.8 Design Features for Health and Safety (HS)

The following design features have been identified to avoid, minimize, and/or mitigate potential health and safety impacts from utility-scale solar energy development on BLM-administered lands.

B.8.1 General

Project developers shall coordinate with the BLM and other federal, state, and local agencies early in the planning process to identify project health and safety risks and methods to minimize those risks.

General design features to avoid, minimize, and/or mitigate potential impacts include:

- **HS-G-1** Project developers shall identify and establish federal and state occupational health and safety standards, such as the Occupational Health and Safety Administration's (OSHA's) Occupational Health and Safety Standards, 29 CFR Parts 1910 and 1926, respectively, for all phases of the project.
- **HS-G-2** Project developers shall identify safety zones or setbacks for solar facilities and associated transmission lines from residences and occupied buildings, roads, ROWs, and other public access areas that are sufficient to prevent accidents resulting from various hazards during all phases of development.
- **HS-G-3** Project developers shall identify and account for general project injury prevention within the POD and the Health and Safety Plan, such as established PPE requirements, respiratory protection, hearing conservation measures, electrical safety considerations, hazardous materials safety and communication, housekeeping and waste handling, confined space identification, and rescue response and emergency medical support, including onsite first-aid capability.
- **HS-G-4** Project developers shall implement training and awareness measures for workers and the general public to minimize and address standard practices (such as OSHA's) for the safe use of explosives and blasting agents;

occupational electromagnetic field (EMF) exposures; fire safety and evacuation procedures; and safety performance standards (e.g., electrical system standards and lighting protection standards). Consider further training for additional health and safety risks from the solar energy project and its ancillary facilities.

- **HS-G-5** Project developers shall establish measures to document training activities and reporting of serious accidents to appropriate agencies.
- **HS-G-6** Project developers shall implement a reporting-and-response structure for accidental release of hazardous substances and petroleum products to the environment. This includes provisions where project developers shall document the event, including a root cause analysis, a description of appropriate corrective actions taken, and a characterization of the resulting environmental or health and safety impacts. Documentation and reporting must comply with the requirements of CERCLA Section 103 and EPCRA Section 304 and any additional requirements of the state and local regulatory agencies.
- **HS-G-7** Project developers shall consider manufacturer requirements, and federal and state standards, when establishing safety zones or setbacks for solar facilities and associated transmission lines.
- **HS-G-8** Project developers shall coordinate with the BLM and appropriate agencies (e.g., the DOE and Transportation Security Administration) to address critical infrastructure and key resource vulnerabilities at solar facilities in order to minimize and plan for potential risks from natural events, sabotage, and terrorism.

B.8.2 Site Characterization, Siting and Design, Construction

- **HS-C-1** Project developers shall design electrical systems to meet all applicable safety standards (e.g., National Electrical Code) and to comply with the interconnection requirements of the transmission system operator.
- **HS-C-2** Project developers shall comply with applicable Federal Aviation Administration (FAA) regulations, including lighting requirements, to avoid or minimize potential safety issues associated with proximity to airports, military bases or training areas, or landing strips.
- **HS-C-3** Project developers shall consider temporary fencing and other measures for staging areas, storage yards, and excavations during construction or decommissioning activities to limit public access to health and safety risks.
- **HS-C-4** Project developers shall plan for traffic management of site access to ensure that traffic flow would not be unnecessarily affected and that specific issues of concern (e.g., the locations of school bus routes and stops) are identified and addressed. Planning may include measures such as informational signs and temporary lane configurations. Planning shall be coordinated with local planning authorities.

- **HS-C-5** Project developers shall consider the use of alternative dielectric fluids that do not contain sulfur hexafluoride (SF_6) to reduce the global warming potential.
- **HS-C-6** Project developers shall consider measures to reduce occupational EMF exposures, such as backing electrical generators with iron to block the EMF, shutting down generators when work is being done near them, and otherwise limiting exposure time and proximity while generators are running.

B.8.3 Operations and Maintenance

- **HS-O-1** Project developers shall comply with the BLM's terms and conditions for health and safety and environmental protection. Consultation with the BLM shall be maintained through operations and maintenance of the project, employing an adaptive management strategy and modifications, as necessary and approved by the BLM.

B.8.4 Decommissioning/Reclamation

- **HS-D-1** All design features developed for the construction phase shall be applied to similar activities during the decommissioning and reclamation phases.

B.9 Design Features for Lands and Realty (LR)

The following design features have been identified to avoid, minimize, and/or mitigate potential impacts on lands and realty from utility-scale solar energy development on BLM-administered lands.

B.9.1 General

Project developers shall consult with the BLM in the early phases of project planning to identify potential land use conflicts and constraints. General design features to avoid, minimize, and/or mitigate potential impacts include:

- **LR-G-1** Project developers shall ensure their proposal prevents unnecessary or undue degradation of highly intact public lands (defined as high or moderate intactness and less than 40% invasive weed cover; see Section 2.1.1.4) identified during the environmental analysis under NEPA.
- **LR-G-2** If the proposed project area is included in the BLM's Restoration Landscapes (see maps in Appendix H), confirm that restoration activities have not been completed, initiated, or are not imminent.
- **LR-G-3** Project developers shall identify potential land use conflicts, including special designation or protections, ROWs, leases, permits, mining claims, and fluid/solid minerals authorizations, in proximity to the proposed project, and have early discussions regarding those existing uses. Developers shall consult existing BLM land use plans and local land use plans, and, in coordination with

the BLM, shall consult with appropriate federal and state agencies, Tribal, and local governments, as well as adjacent property owners and grazing permittees that may be affected by the proposed project.

- **LR-G-4** Pursuant to Title 43, Part 2807.14 of the *Code of Federal Regulations* (43 CFR 2807.14), the BLM shall notify near or adjacent ROW holders regarding the proposed solar energy development application and request a response as to how the proposed use may affect the integrity of, or their ability to operate, their facilities. Similarly, adjacent landowners shall be notified.
- **LR-G-5** Project developers shall identify legal access to private, state, and federal lands surrounding solar facilities, including any ancillary facilities, and the potential to create areas inaccessible to the public.
- **LR-G-6** Project developers shall consider the effects on the manageability and uses of public lands around boundaries of solar energy facilities.
- **LR-G-7** Project developers shall evaluate land use impacts and constraints as part of the environmental impact analysis for the project and consider options to avoid, minimize, and/or mitigate adverse impacts in coordination with the BLM.
- **LR-G-8** For proposed solar energy developments within one-quarter mile of any project boundary, project developers shall obtain a Chain of Survey Certificate in conformance with departmental standard. In some cases, Land Description Reviews, Certificates of Inspection and Possession, Boundary Assurance Certificates, resurveys, re-monumentation, and/or referencing of Public Land Survey System (PLSS) corners may be required before the start of any action.
- **LR-G-9** Project developers shall inform project personnel of all laws and regulations that they may be subject to, such as international borders, limitations on the removal of salable materials such as stone or wood from a project site for personal use, and use of vehicles off the project site in limited-access areas. This information shall be incorporated into a WEAP, prepared by the project developer, that is provided to all project personnel prior to entering the project worksite. The WEAP shall be provided on a regular basis, covering multiple resources, to ensure the awareness of key mitigation efforts for the project worksite during all phases of the project's life. The base information the WEAP provides shall be reviewed and approved by the BLM prior to the issuance of a Notice to Proceed and incorporate adaptive management protocols for addressing changes over the life of the project, should they occur.

B.9.2 Site Characterization, Siting and Design, Construction

- **LR-C-1** Project developers shall locate proposed generation-tie, interconnect, or transmission lines that are ancillary to a solar development project within corridors designated for transmission, where geographically and environmentally feasible. Where transmission corridors are not geographically or environmentally feasible, project developers shall site lines related to the solar development project in areas where they are best compatible with the land use plan.

- **LR-C-2** Project developers shall encourage new solar development projects outside of designated transmission corridors by prioritizing solar development projects outside of designated transmission corridors. For solar development projects proposed within designated transmission corridors, the BLM would look at preserving the usefulness of the corridors and consider when corridors might be rendered ineffective/impractical by a proposed project; the BLM reserves the discretion to reject the proposal or consider realigning all or part of the corridor through a plan amendment.
- **LR-C-3** Project developers shall identify and protect evidence of the PLSS and related federal property boundaries prior to commencement of any ground-disturbing activity. This shall be accomplished by contacting the BLM Cadastral Survey to coordinate data research, evidence examination and evaluation, and locating, referencing, or protecting monuments of the PLSS and related land boundary markers from destruction. In the event of obliteration or disturbance of the federal boundary evidence, the project developers shall immediately report the incident, in writing, to the Authorizing Official. The BLM Cadastral Survey shall determine how the marker is to be restored. In rehabilitating or replacing the evidence the project developers shall use the services of a Certified Federal Surveyor, whose procurement shall be per qualification-based selection, or to reimburse the BLM for costs. All surveying activities shall conform to the Manual of Surveying Instructions and appropriate state laws and regulations. Local surveys shall be reviewed by Cadastral Survey before being finalized or filed in the appropriate state or county office. The project developers shall pay for all survey, investigation, penalty, and administrative costs.

B.10 Design Features for Military and Civilian Aviation (MCA)

The following design features have been identified to avoid, minimize, and/or mitigate potential impacts on military and civilian aviation from utility-scale solar energy development on BLM-administered lands.

B.10.1 General

Project developers shall coordinate with the BLM, military personnel, and civilian airspace managers early in the project planning process to identify and minimize impacts on military and civilian airport and airspace use. General design features to avoid, minimize, and/or mitigate potential impacts include:

- **MCA-G-1** Project developers shall submit plans for proposed construction of any facility that is 200 ft (~61 m) or taller and plans for other projects located in proximity to airports to the FAA to evaluate potential safety hazards.
- **MCA-G-2** Project developers shall consult with the DoD to minimize and/or eliminate impacts on military operations, and encouraging compatible development. This consultation will be initiated by the BLM and will include both general discussions for early planning and detailed assessments of specific

proposals at the local level. The BLM will accept formal DoD submissions once they have been vetted through both the military departments and the DoD Siting Clearinghouse.

- **MCA-G-3** Project developers shall evaluate impacts on military and civil aviation as part of the environmental impact analysis for the project and consider options to avoid, minimize, and/or mitigate adverse impacts in coordination with the BLM.
- **MCA-G-4** For any temporary or permanent structure, including all appurtenances, that exceeds any obstruction standard contained in 14 CFR Part 77 or an overall height of 200 ft (60.96 m) above ground level, project developers shall ensure the structure is marked and/or lighted. The FAA could recommend marking and/or lighting a structure that does not exceed 200 ft (61 m) above ground level or that is not within the distances from airports or heliports mentioned above, because of its particular location (FAA 2020).

B.10.2 Site Characterization, Siting and Design, Construction

- **MCA-C-1** The project owners shall establish a toll-free number for the public to report complaints related to glare from solar panels. If the project owners receive a complaint regarding glare from panels, they shall investigate to determine whether the complaint is legitimate and if the project is the source of the glare. If it is determined that the project is the source of glare and it is causing human health or safety hazards, the project owner shall take all feasible measures to reduce the glare (BLM 2018). Proper siting of solar energy installations, taking into account the size of the solar energy system, distance, orientation, environmental conditions, and key observation points, is perhaps the most effective way to mitigate the negative impacts of glare. Textured glass and anti-reflective coatings can greatly reduce the reflectance of PV modules, including the selection of PV modules with a high absorption factor (Sreenath et al. 2020).

B.10.3 Operations and Maintenance

No design features for military and civilian aviation have been identified for the operations and maintenance phase of solar energy development.

B.10.2 Decommissioning/Reclamation

No design features for military and civilian aviation have been identified for the decommissioning/reclamation phase of solar energy development.

B.11 Design Features for Minerals (M)

The following design features have been identified to avoid, minimize, and/or mitigate potential impacts on mineral resources from utility-scale solar energy development on BLM-administered lands.

B.11.1 General

Project developers shall consult with the BLM, Tribes, and state geological survey and fluid or hard rock mining regulatory offices in the early phases of project planning to identify potential impacts on mineral development activities and ways to minimize potential adverse impacts. General design features to avoid, minimize, and/or mitigate potential impacts include:

- **M-G-1** Project developers shall identify active mining claims or mineral development activities and potential for mineral development in proximity to a proposed project. In coordination with the BLM, Tribal, state, and county agencies, developers shall consult existing land use plans and updated inventories.
- **M-G-2** Project developers shall evaluate impacts on mineral development, including mineral potential, as part of the environmental impact analysis for the project and consider options to avoid, minimize, and/or mitigate adverse impacts in coordination with the BLM, Tribal, state, and county agencies.
- **M-G-3** The BLM shall issue all solar energy development ROWs with a stipulation that the BLM retains the right to issue oil and gas or geothermal leases with a stipulation of no surface occupancy within the ROW area. If a solar development ROW is granted, the area will be classified as no surface occupancy for oil and gas and geothermal leasing.

B.11.2 Site Characterization, Siting and Design, Construction

- **M-C-1** Project developers shall, to the maximum extent practicable, ensure that the solar energy project avoids conflicts with valid existing mineral rights, areas of mineral potential, and/or ongoing mineral development.
- **M-C-2** Project developers shall consider siting solar energy projects in areas with ongoing mineral or mining activities, and consider incentivizing colocation of disturbance and activities.
- **M-C-3** Project developers shall, to the maximum extent practicable, locate transmission lines to avoid conflicts with mining activities in areas with active mineral development.

B.11.3 Operations and Maintenance

No design features for minerals have been identified for the operations and maintenance phase of solar energy development.

B.11.4 Decommissioning/Reclamation

No design features for minerals have been identified for the decommissioning/reclamation phase of solar energy development.

B.12 Design Features for Paleontological Resources (P)

The following design features have been identified to avoid, minimize, and/or mitigate potential impacts on paleontological resources from utility-scale solar energy development on BLM-administered lands.

B.12.1 General

Project developers shall coordinate with the BLM early in the project planning process to identify and minimize impacts on paleontological resources. General design features to avoid, minimize, and/or mitigate potential impacts include:

- **P-G-1** Project developers shall determine, in coordination with the BLM, whether known paleontological resources or previously documented sites exist in a project area.
- **P-G-2** Project developers shall determine the potential presence of paleontological resources on the basis of the following: the geological context of the area and its potential to contain paleontological resources (potential fossil yield classification [PFYC] class, if available); a records search of published and unpublished literature and locality data for past paleontological finds in the area; coordination with paleontological researchers working locally in potentially affected geographic areas and geologic strata; and/or depending on the extent of existing information, the completion of a paleontological survey.

For projects where important paleontological resources have been identified within the project footprint, project developers shall also identify and minimize impacts by:

- **P-G-3** Project developers shall institute BMPs, such as training/education programs (see WEAP]bullet below), to reduce the amount of inadvertent destruction to paleontological sites. Project-specific management practices shall be established in coordination with the BLM, incorporating best practices such as those mentioned in Murphey et al (2019).
- **P-G-4** Project developers shall plan for the mitigation of paleontological resources within the project area that have known paleontology localities and areas categorized as PFYC 4, 5, and U (unknown).
- **P-G-5** Project developers shall identify measures to prevent potential looting/vandalism or erosion impacts and addressing the education of the public to make them aware of the consequences of unauthorized collection of fossils on public land.
- **P-G-6** Project developers shall incorporate key elements, such as PFYC status, to mitigate the impacts on paleontological resources into a WEAP that is provided to all project personnel prior to entering the project worksite. The WEAP shall be provided to all personnel upon onboarding for the project covering multiple resources, to ensure the awareness of key mitigation efforts for paleontological resources of the project worksite during all phases of the

project's life. The base information the WEAP provides shall be reviewed and approved by the BLM prior to the issuance of a Notice to Proceed and shall incorporate adaptive management protocols for addressing changes over the life of the project, should they occur.

- **P-G-7** Project developers shall incorporate environmental inspection and monitoring measures into PODs and other relevant plans to monitor and respond to paleontological resource impacts during construction, operations, and decommissioning of a solar energy development, including adaptive management protocols.
- **P-G-8** Project developers shall avoid of high fossil potential areas based on PFYC classification and other known sources such as ACECs and other state paleontological areas.

B.12.2 Site Characterization, Siting and Design, Construction

- **P-C-1** Project developers shall use a BLM-permitted paleontological consultant to conduct a paleontology survey in areas that are known to contain paleontological resources as well as in areas of PFYC 4, 5, or U (unknown) prior to starting any groundwork. If the paleontological survey shows considerably high quantities of fossils or fossils of high scientific importance are present, a BLM-permitted paleontological consultant shall conduct data recovery activities, such as excavation, if considered appropriate by the BLM paleontologist.
- **P-C-2** Project developers shall use a BLM-permitted paleontological consultant to monitor excavation and earthmoving activities in areas that are known to contain paleontological resources as well as in areas of PFYC 4, 5, or U (unknown).
- **P-C-3** Project developers shall notify the BLM immediately upon discovery of fossils or potential fossils. Work shall be halted at the discovery site and continued elsewhere until a BLM paleontologist and/or a qualified BLM-permitted paleontological consultant can visit the site, determine the significance of the find and, if significant, make site-specific recommendations for collection or other resource protection. The area of the discovery shall be protected to ensure that the fossils are not removed, handled, altered, or damaged until the site is properly evaluated and further action determined.

B.12.3 Operations and Maintenance

No design features for paleontological resources have been identified for the operations and maintenance phase of solar energy development.

B.12.4 Decommissioning/Reclamation

- **P-D-1** All design features developed for the construction phase shall be applied to similar activities during the decommissioning and reclamation phases, to minimize impacts from additional ground disturbance.

B.13 Design Features for Rangeland Resources

B.13.1 Design Features for Livestock Grazing (LG)

The following design features have been identified to avoid, minimize, and/or mitigate potential impacts on grazing from utility-scale solar energy development on BLM-administered lands.

B.13.1.1 General

Project developers shall consult with the BLM early in project planning to identify activities that could impact rangeland resources and grazing. They shall also coordinate with state departments of agriculture and permittees as appropriate.

General design features to avoid, minimize, and/or mitigate potential impacts include:

- **LG-G-1** The BLM and project developers shall identify rangeland resources and grazing use in proximity to proposed projects. In coordination with the BLM, developers shall consult existing land use plans and updated inventories.
- **LG-G-2** The BLM and project developers shall coordinate with affected grazing permittees/lessees to discuss how a proposed project may affect grazing operations and to address possible alternatives to avoid and minimize impacts as well as mitigation and compensation strategies.
- **LG-G-3** Project developers shall evaluate impacts on rangeland resources and grazing use as part of the environmental impact analysis for the project, and consider options to avoid, minimize, and/or mitigate adverse impacts in coordination with the BLM. Issues to be considered include but are not limited to:
    - Loss/reduction of AUMs; effects on grazing systems;
    - The potential of suspending substantial portions or entire grazing allotments/permits or leases while the right-of-way is in effect, and the associated socio-economic impacts;
    - Maintenance or relocation of range improvements (such as cattle guards) and fencing;
    - Access to water and water rights;
    - Delineation of open range;
    - Potential proliferation of weeds;
    - Traffic management; and,
    - The need for new, or modifications to existing, rangeland health inventory, assessment and monitoring projects.
- **LG-G-4** Where feasible, the project developer and the BLM shall configure the boundaries of solar leases to allow grazing operations to continue in whole or in part.

B.13.1.2 Site Characterization, Siting and Design, Construction

- **LG-C-1** Facilities and supporting infrastructure, including roads, shall be designed, constructed, improved, and maintained to minimize their impact on grazing operations. Road design shall include fencing, cattle guards, gates, and speed control and information signs where appropriate.

B.13.1.3 Operations and Maintenance

- **LG-G-1** Project developers shall require traffic management measures (e.g., vehicle speed limits) to be adhered to on and near the site, for the protection of animals grazing near the site.

B.13.1.4 Decommissioning/Reclamation

LG-D-1 For areas previously used for livestock grazing, the site operator shall build fences as necessary to exclude livestock from reclamation areas until it is determined by the applicable field office that the area is reclaimed and that the area is suitable for livestock grazing, **both** The BLM shall consider prioritizing reauthorization of grazing permit to original permittee.

B.13.2 Design Features for Wild Horses and Burros (WH&B)

The following design features would avoid, minimize, and/or mitigate potential impacts on wild horses and burros (WH&B) from utility-scale solar energy development on BLM-administered lands.

B.13.2.1 General

Project developers shall coordinate with the BLM, state departments of agriculture and game and fish departments, and other stakeholders early in the project planning process to assess and consider options to avoid, minimize, and/or mitigate impacts on WHBs and their herd management areas (HMAs).

General design features to avoid, minimize, and/or mitigate potential impacts include:

- **WHB-G-1** Project developers shall identify WHBs and their HMAs in proximity to the proposed project. In coordination with the BLM, developers shall consult existing land use plans and updated inventories.
- **WHB-G-2** Project developers shall evaluate potential impacts on WHBs and their management areas as part of the environmental impact analysis for the project and considering options to avoid, minimize, and/or mitigate adverse impacts in coordination with the BLM.
- **WHB-G-3** Project developers shall require traffic management measures (e.g., vehicle speed limits).
- **WHB-G-4** Project developers and the BLM shall ensure access to or replacement of water sources.

- **WHB-G-5** Project developers shall incorporate key elements to mitigate impacts on WHB in a WEAP that is provided to all project personnel prior to entering the project worksite. The WEAP shall be provided on a regular basis, covering multiple resources, to ensure the awareness of key WHB mitigation efforts at the project worksite during all phases of the project's life. The base information the WEAP provides shall be reviewed and approved by the BLM prior to the issuance of a Notice to Proceed and shall incorporate adaptive management protocols for addressing changes over the life of the project, should they occur.

B.13.2.2 Site Characterization, Siting and Design, Construction

- **WHB-C-1** Project developers shall, to the maximum extent practicable, site, design, construct, fence, and improve access roads to minimize potential WHB collisions. Fences or other appropriate structures shall be constructed to exclude WHBs from solar energy project site facilities. Either water sources or access routes to water sources for WHB shall be excluded from the solar energy development area, or alternate water sources or routes shall be provided. However, alternative water sources shall not result in concentrating large numbers of animals in one area, and may be best utilized by developing water sources across the landscape.

B.13.2.3 Operations and Maintenance

No design features for WHBs have been identified for the operations and maintenance phase of solar energy development.

B.13.2.4 Decommissioning/Reclamation

No design features for WHBs have been identified for the decommissioning/ reclamation phase of solar energy development.

B.14 Design Features for Recreation (R)

The following measures have been identified to avoid, minimize, and/or mitigate potential impacts on public access and recreation from utility-scale solar energy development on BLM-administered lands.

B.14.1 General

Project developers shall consult with the BLM and local governments in the early phases of project planning to identify public access and recreation use areas in and adjacent to a project site.

General design features to avoid, minimize, and/or mitigate potential impacts include:

- **R-G-1** Project developers, in coordination with the BLM, shall assess existing public access through or around proposed solar facilities that allows for access to and use of BLM-administered public lands and non-BLM administered lands.

  - Developers shall conduct this assessment in coordination with the BLM and consult existing land use plans, including travel and recreation management plans.
  - Developers and the BLM shall Identify legal access to private, state, and federal lands surrounding the solar facilities to avoid creating areas that are inaccessible to the public.
- **R-G-2** Project developers shall evaluate impacts on public access and recreation as part of the environmental impact analysis for the project and considering options to avoid, minimize, and/or mitigate adverse impacts in coordination with the BLM. Site- and project-specific analysis of impacts on recreational use of solar development project sites shall include a thorough review of both on- and offsite impacts on dispersed recreation associated with the proposed development.

B.14.2 Site Characterization, Siting and Design, Construction

- **R-C-1** Solar facilities shall not be sited in areas designated as unique or important recreation resources, where it has been determined that a solar facility or other such development of the land would be in direct conflict with the recreation objectives of the relevant management plan.

B.14.3 Operations and Maintenance

No design features for recreation have been identified for the operations and maintenance phase of solar energy development.

B.14.4 Decommissioning/Reclamation

No design features for recreation have been identified for the decommissioning/ reclamation phase of solar energy development.

B.15 Design Features for Socioeconomics (S)

The economic effects of solar energy projects can be positive, with increases in employment, income, and state tax revenues; thus, few if any mitigation measures may be necessary. On the basis of the potential magnitude of employment impacts from large PV solar energy facilities; however, it is possible that socioeconomic impacts, notably the impacts of in-migrating workers on local housing markets and on local government expenditures and employment, would require mitigation measures. A large in-migrant labor force has the potential to produce some degree of social disruption, whereby the cultural and social values of in-migrants conflict with those of the resident population, potentially creating alienation, crime, alcoholism, drug use, mental health problems, and the disruption of family life.

B 15.1 General

The following measures have been identified to avoid, minimize, and/or mitigate potential socioeconomic impacts from utility-scale solar energy development on BLM-administered lands.

- **S-G-1** If the environmental impact analysis for a project concludes that the project is likely to have a substantial negative impact on the economic or social conditions of local communities, project developers shall work with state, local, and Tribal agencies and governments to develop community monitoring programs that would be sufficient to identify and evaluate socioeconomic impacts of proposed solar energy development, in order to predict potential impacts in the vicinity of individual projects. Monitoring programs shall collect data reflecting the economic, fiscal, demographic, and social impacts of development at the state, local, and Tribal levels. Parameters to be evaluated shall include impacts on local labor and housing markets, local consumer product prices and availability, local public services (police, fire, and public health), and educational services. Programs shall also monitor indicators of social disruption (e.g., crime, alcoholism, drug use, and mental health) and the effectiveness of community welfare programs in addressing these problems.

B.15.2 Site Characterization, Siting and Design, Construction

No design features for socioeconomic impacts have been identified for the site characterization, siting and design, construction phase of solar energy development.

B.15.3 Operations and Maintenance

No design features for socioeconomic impacts have been identified for the operations and maintenance phase of solar energy development.

B.15.4 Decommissioning/Reclamation

No design features for socioeconomic impacts have been identified for the decommissioning/reclamation phase of solar energy development.

B.16 Design Features for Specially Designated Areas and Lands with Wilderness Characteristics (SDLW)

The following design features have been identified to avoid, minimize, and/or mitigate potential impacts on specially designated areas and Lands with Wilderness Characteristics (LWCs) from utility-scale solar energy development on BLM-administered lands. While areas for which applicable land use plans establish protection for lands with wilderness characteristics are excluded from solar energy development (see Table 2.1.3), these design features may be applicable for other lands with wilderness characteristics as well.

B.16.1 General

To the maximum extent practicable, the policy and procedures provided in BLM manuals pertaining to specially designated areas and LWCs shall be followed. These include Manuals MS-6100 (BLM 2012a), MS-6220 (BLM 2017), MS-6250 (BLM 2012b), MS-6280 (BLM 2012c), MS-6310 (BLM2012a), MS-6320 (BLM 2021b), MS-6330 (BLM 2012d), MS-6340 (BLM 2012e), and MS-6400 (BLM 2012f). Because specially designated areas and LWCs will be excluded from solar development, no design features are required for direct impacts to these areas for solar facilities. Indirect impacts on and protection of existing values of specially designated areas and LWCs shall be evaluated during the environmental analysis for solar energy projects, and the results shall be incorporated into the project planning and design. Similar evaluations shall be done for transmission lines and roads; which could also involve the need to mitigate direct impacts to specially designated areas such as National Scenic and Historic Trails (NSHTs). To the maximum extent practicable, project relocation shall be considered in cases where the impacts on values of specially designated areas or LWCs cannot be minimized or mitigated.

General design features to avoid, minimize, and/or mitigate potential impacts include:

- **SDLW-G-1** Project developers shall identify specially designated areas and LWCs in proximity to the proposed projects. In coordination with the BLM, developers shall consult current land use plans and inventories. In some cases, an updated inventory may be needed.
- **SDLW-G-2** Project developers shall identify lands within the geographic scope of the proposed solar energy project to determine if they have been inventoried for wilderness characteristics or any lands that have been identified in a citizen's wilderness proposal. If wilderness characteristics inventory findings are not current or not inventoried, project developers shall consider conducting the wilderness characteristics evaluations to determine whether lands within the geographic scope of the proposed solar energy project possess wilderness characteristics. If there are existing BLM wilderness characteristics inventory findings on file regarding the presence or absence of individual wilderness characteristics, developers shall consider the information of the evaluations to identify LWCs in proximity to the proposed projects. Developers shall consider including the wilderness characteristics evaluation as part of the processing of a solar energy ROW application for those lands without a recent wilderness characteristics inventory. All work must be completed in accordance with current BLM policies and procedures.
- **SDLW-G-3** Project developers shall evaluate impacts on specially designated areas and LWCs as part of the environmental impact analysis for the project and consider options to avoid, minimize, and/or mitigate adverse impacts in coordination with the BLM.
- **SDLW-G-4** The BLM and project developers shall consider National Trail management corridors established through the land use planning process as

exclusion areas in order to prevent substantial interference with the nature and purposes of designated NSHTs, and to make efforts to avoid activities incompatible with trail purposes (NTSA Sec. 7(c)). NSHT management corridors are established in a land use plan through the NSHT IAM Inventory Assessment and Monitoring Methodology (6280 Volume 1 and 2). The BLM and project developers are required to ensure adequate protections for trails or trails under study. The BLM should update RMPs to the accepted and current National Trail inventory process outlined in the manuals. The BLM and project developers must conduct these updates in consultation with the trail administering agency, Tribes, and other partner organizations (BLM 2020a,b). The inventory process identifies the management corridor; the area that, if developed, would have an adverse impact on the resources, qualities, values, and associated settings; and the primary use or uses of the trails within the viewshed. Project developers shall prevent substantial interference and determine any areas unsuitable for development. Residual impacts on trails shall be avoided, minimized, and/or mitigated to the maximum extent practicable according to program policy standards.

- **SDLW-G-5** Project developers shall determine the size of the area (corridor) of possible adverse impact through the results of the required inventory, in consultation with the trail administering agency. There is no current established minimum or maximum limit on the size of the area of possible adverse impact, however, it must include all the resources associated with the nature and purpose of designation. The landscape elements design feature requirements and coordination requirements, for cultural resources, recreation and visitor services, visual resources, natural resources, or NCLs must also be met.
- **SDLW-G-6** Project developers shall review the adequacy of information from NSHT inventory projects underway during the project-specific environmental reviews in accordance with NEPA by the BLM at the field office level in coordination with the trail administering agency, Tribes, and partner trail organizations and application of the data to determine the area of possible adverse impact for any anticipated development. Such inventory projects may reveal unanticipated or undocumented remnants, artifacts, trail tread or trace, the location of high potential historic sites and high-potential route segments, trail features, and/or the associated settings for NSHTs adjacent to or within proposed project.
- **SDLW-G-7** Project developers shall consult with state or local agencies to determine if a project could have an adverse impact on trails designated by a state or local trails master plan.
- **SDLW-G-8** Project developers shall apply on- or offsite mitigation for any residual adverse impact according to program policy standards, and mitigation or impact reduction measures identified for related program areas in this document.

B.16.2 Site Characterization, Siting and Design, Construction

- **SDLW-C-1** Project developers shall, to the maximum extent practicable, site, design, and construct solar facilities and associated facilities to avoid, minimize, and/or mitigate impacts on the values of specially designated areas and LWCs.

B.16.3 Operations and Maintenance

No design features for impacts on specially designated areas and LWCs have been identified for the operations and maintenance phase of solar energy development.

B.16.4 Decommissioning/Reclamation

No design features for impacts on specially designated areas and LWCs have been identified for the decommissioning/reclamation phase of solar energy development.

B.17 Design Features for Transportation (T)

The following design features have been identified to avoid, minimize, and/or mitigate potential impacts on transportation from utility-scale solar energy development on BLM-administered lands.

B.17.1 General

Depending on site-specific characteristics, a number of design features shall be required for transportation impacts. Appropriate measures shall be determined during the siting and design phase through the development of a Transportation Plan and a Traffic Management Plan.

General design features to avoid, minimize, and/or mitigate potential impacts include:

- **T-G-1** The BLM shall, to the maximum extent practicable, require easements for public roadway corridors through project sites to maintain proper traffic flows and retain more direct routing for the local population.
- **T-G-2** The project developer shall, to the maximum extent practicable, implement local road improvements, provide multiple site access locations and routes, stagger work schedules for different work functions (e.g., site preparation, array foundation installation, array assembly, and electrical connections), shift work hours to facilitate off-peak commuting times to minimize impact on local commuters, and/or implement a ride-sharing or shuttle program. These actions will mitigate impacts related to the daily commutes of construction workers.
- **T-G-2** The project developer shall, to the maximum extent practicable, implement traffic control measures, such as intersection realignment coupled with speed limit reduction; the installation of traffic lights and/or other signage; and the addition of acceleration, deceleration, and turn lanes on routes with site

entrances. These actions will reduce hazards for incoming and outgoing traffic, as well as expedite traffic flow. These types of measures shall be considered during the siting and design phase through development of the following plans:

- Transportation Plan, particularly for oversized or overweight components specific to solar energy development. The plan shall consider component sizes, weights, origin, destination, and unique handling requirements. It shall also evaluate alternate transportation approaches (e.g., rail).
- Traffic Management Plan for site access roads and for the use of main public roads. The plan shall include road design, construction, and management standards. It also shall incorporate consultation with local planning authorities regarding traffic in general and specific issues such as school bus routes and stops.

B.17.2 Site Characterization, Siting and Design, Construction

- **T-C-1** Project developers shall assess the potential for transportation impacts associated with the proposed project in coordination with the BLM and other appropriate state and local agencies, consulting land use plans, transportation plans, and local plans to the maximum extent practicable. The developer shall perform traffic studies, analyses, or other studies of the capacity of existing and proposed new roads to physically handle the added wear and tear from increased construction commuter and truck traffic.
- **T-C-2** Project developers shall evaluate transportation impacts as part of the environmental impact analysis for the project and, to the maximum extent practicable, consider options to avoid, minimize, and/or mitigate such risk in coordination with the BLM.
- **T-C-3** Project developers shall implement traffic control measures to reduce hazards for incoming and outgoing traffic and streamline traffic flow, such as intersection realignment and speed limit reductions; install traffic lights and/or other signage; and add acceleration, deceleration, and turn lanes on routes with site entrances.
- **T-C-4** Project developers, in coordination with the BLM, shall incorporate environmental inspection and monitoring measures into the POD and other relevant plans to monitor and respond to transportation impacts during construction, operations, and decommissioning of a solar energy development, including adaptive management protocols.

B.17.3 Operations and Maintenance

No design features for impacts on transportation have been identified for the operations and maintenance phase of solar energy development.

B.17.4 Decommissioning/Reclamation

No design features for impacts on transportation have been identified for the decommissioning/reclamation phase of solar energy development.

B.18 Design Features for Tribal Interests (TI)

The following design features have been identified to avoid, minimize, and/or mitigate potential impacts in areas of Tribal Interests from utility-scale solar energy development on BLM-administered lands.

B.18.1 General

The BLM shall consult with federally recognized Indian Tribes early in the planning process to identify issues and areas of concern regarding any proposed solar energy project as required by the National Historic Preservation Act (NHPA) and other authorities to determine whether construction and operation of a project is likely to disturb traditional cultural properties or sacred sites, impede access to culturally important locations, disrupt traditional cultural practices, affect movements of animals important to Tribes, or visually affect culturally important landscapes.

The BLM shall coordinate with federally recognized Indian Tribes to identify and minimize impacts on areas of concern by:

- **TI-G-1** The BLM shall discuss planning, construction, operation, and reclamation activities during consultation. Agreements or understandings reached with affected Tribes through consultation shall be carried out in accordance with the terms of MOAs or State Specific Procedures as defined within the nPA and Solar PA for those states that are party to the latter.
- **TI-G-2** The BLM shall consult with affected Indian Tribes prior to the Section 106 process to include indigenous knowledge in the development of historic contexts in the Section 106 process. The BLM shall additionally consult with Indian Tribes during the Section 106 process at the points specified in the nPA and Solar PA.
- **TI-G-3** The BLM shall consult with Indian Tribes under the terms of the Native American Graves Protection and Repatriation Act (NAGPRA). Any planning for treatment of historic properties or mitigation will take such consultations into account.
- **TI-G-4** The BLM shall consider management of Tribal resources holistically to mitigate damage to the integrity of the landscape as a whole.

For projects where areas of concern to federally recognized Indian Tribes have been identified through the general design features listed above, project developers shall also identify and minimize impacts by performing the following:

- **TI-G-5** Project developers shall employ standard noise design features for solar facilities located near sacred sites to minimize the impacts of noise on culturally significant areas. Noise levels have the potential to affect wildlife behavior that may inhibit the ability for Tribes to capture or hunt wildlife. Noise levels may impact the sacredness of cultural important areas and sites such as human burial sites, archaeological sites, springs or other sacred water source areas, viewshed areas for observance of cultural areas of significance such as rock writings, and gathering areas with important plant resources.
- **TI-G-6** Project developers shall employ health and safety design features for the general public for solar facilities located near Tribal traditional use areas in order to minimize potential health and safety impacts on Tribes.
- **TI-G-7** Project developers shall validate through consultation with appropriate Tribal governments and cultural authorities any Tribal archaeological or other culturally important site inventoried in project areas. Appropriate mitigation steps, such as avoidance, removal, repatriation of Native American human remains and associated items of cultural patrimony, or curation, shall be determined during this consultation.
- **TI-G-8** Project developers shall avoid archaeological sites created by ancestral Native American populations whenever possible along with providing access for Tribes to visit culturally important archaeological sites. When archaeological excavations are necessary, affiliated Tribe(s) shall be consulted, and the concerns of the affected descendant Native American population taken into account when developing a data recovery strategy
- **TI-G-9** Project developers shall avoid known human burial sites and retaining access for Tribes to visit burial sites.
- **TI-G-10** Where there is a reasonable probability of encountering undetected human remains and associated funerary objects by a solar energy project, the BLM shall carry out discussions with Indian Tribes before the project is authorized, in order to provide general guidance on the treatment of any cultural items (as defined by NAGPRA) that might be exposed.
- **TI-G-11** Project developers shall avoid visual intrusion on sacred sites along with visual intrusion on viewshed areas Tribes may use through the selection of the solar facility location and design.
- **TI-G-12** When complete avoidance of visual intrusion is not practicable or economically feasible, the BLM shall engage in timely and meaningful consultation with the affected Tribe(s) and shall attempt to formulate a mutually acceptable plan to resolve or minimize the adverse effects.
- **TI-G-13** Project developers shall avoid rock writings (panels of petroglyphs and/or pictographs) and retaining access for Tribes to visit sacred and cultural important areas. These panels may be just one component of a larger sacred landscape, in which avoidance of all impacts may not be possible. Mitigation plans for eliminating or minimizing potential impacts on rock writings shall be formulated in consultation with the appropriate Tribal cultural authorities.

- **TI-G-14** Project developers shall avoid springs and other water sources that are or may be sacred or culturally important along with retaining access for Tribes to visit sacred and culturally important areas. If it is necessary for construction, maintenance, or operational activities to take place in proximity to springs or other water sources, appropriate measures, such as the use of geotextiles or silt fencing, shall be taken to prevent silt from degrading water sources. The effectiveness of these mitigating barriers shall be monitored. Measures for preventing water depletion impacts on springs shall also be employed. Particular mitigations shall be determined in consultation with the appropriate Indian Tribe(s).
- **TI-G-15** Project developers shall avoid culturally important plant species along with retaining access to such resources for Tribes to carry out their treaty rights. When it is not possible to avoid affecting these plant resources, consultations shall be undertaken with the affected Indian Tribe(s). If the species is available elsewhere on BLM-administered lands, guaranteed access may suffice. For rare or less-common species, establishing (transplanting) or propagating an equal amount of the plant resource elsewhere on BLM-administered lands accessible to the affected Tribe may be acceptable (e.g., for mesquite groves and rice grass fields, identified as Tribally important plant species in previous ethnographic studies).
- **TI-G-16** Project developers shall avoid culturally important mineral resources along with retaining access to such resources for Tribes. When it is not possible to avoid these mineral resources, consultations shall be undertaken with the affected Indian Tribe(s).
- **TI-G-17** Project developers shall avoid culturally important wildlife species and their habitats along with retaining access to such resources for Tribes to carry out their treaty rights. When it is not possible to avoid these habitats, solar facilities shall be designed to minimize impacts on game trails, migration routes, and nesting and breeding areas of Tribally important species. Mitigation and monitoring procedures shall be developed in consultation with the affected Tribe(s).
- **TI-G-18** Project developers shall avoid damage to access roads or pathways Tribes may use to practice treaty rights, such as hunting, fishing, or gathering, and accessing resources or areas of significant cultural importance. When considering elements needed for utility-scale solar energy development, infrastructure such as permanent access roads and transmission lines may block or cut off access to federal and non-federal lands where Tribally significant resources are located.
- **TI-G-19** Project developers shall identify ways to limit or avoid poor air quality from utility-scale solar energy development in areas that may contain Tribally significant resources such as areas with Tribal human burial sites, archaeological sites, springs or other sacred water source areas, viewshed areas for observance of cultural areas of significance such as rock writings, and areas with important plants, minerals, or wildlife.

- **TI-G-20** The BLM shall secure a performance and reclamation bond for all solar energy generation facilities to ensure compliance with the terms and conditions of the ROW authorization. When establishing bond amounts and conditions, the BLM authorized officer shall require coverage of all expenses tied to identification, protection, and mitigation of cultural resources of concern to Indian Tribes. These may include, but are not limited to, costs for ethnographic studies, inventory, testing, geomorphological studies, data recovery, curation, monitoring, treatment of damaged sites, and generation and submission of reports (see IM-2019-013, as cited in Chapter 3, Section 3.3.1).

B.18.2 Site Characterization, Siting and Design, Construction

- **TI–C-1** Just prior to construction, the project developer shall provide cultural awareness training to contractor personnel whose activities or responsibilities could affect issues and areas of concern to federally recognized Indian Tribes. These trainings shall be developed with input from the SHPOs/THPOs and Tribes.
- **TI-C-2** During construction, the BLM shall seek to develop agreements with affected Tribes on how to appropriately respond to input and concerns in advance to save time and avoid confusion.

B.18.3 Operations and Maintenance

- **TI-O-1** The BLM shall continue consultation with affected federally recognized Indian Tribes throughout the life of the project as required for federal agencies.
- **TI-O-2** The BLM shall consult SHPOs/THPOs and Tribes for development of a Historic Properties Management Plan to govern preservation of historic properties that remain following construction and throughout the term of ROW.
- **T1-0-3** The project developer shall train facility personnel regarding their responsibilities to protect any known resources of importance to federally recognized Indian Tribes.

B.18.4 Decommissioning/Reclamation

- **TI-D-1** The project developer shall confine decommissioning and reclamation activities to previously disturbed areas and existing access roads to the extent practicable.
- **TI-D-2** The project developer shall consult with the SHPOs/THPOs, Indian Tribes, and any other consulting parties to identify appropriate decommissioning requirements and return the site to its pre-construction condition, to the extent practicable and approved by the BLM.

B.19 Design Features for Visual Resources (VR)

Design features addressing potential visual impacts during the various project phases (Site Characterization; Siting and Design, Construction, Operations; and Decommissioning/Reclamation) are presented in the following sections. Design features were identified to avoid, minimize, and/or compensate for impacts on visual resources from utility-scale solar energy development on BLM-administered lands.

B.19.1 General

Project developers shall consult with the BLM in the early phases of project planning to determine if a proposed project's changes to the visual landscape would be in conformance with the VRM class objectives in the project proposal area and to identify any other potential resource constraints, thus avoiding costly unforeseen planning implications and re-design. Consultation with the BLM shall be maintained through operations and maintenance of the project, employing an adaptive management strategy and modifications, as necessary and approved by the BLM.

- **VR-G-1** Project developers shall consult with the appropriate BLM field office for VRM class allocations and associated management objectives during the early phases of project planning, including those related to project site selection, planning, and design. Project developers shall consider the BLM visual resource inventory (VRI) class values—including the underlying factors (scenic quality, sensitivity, and distance zones) prior to any further project planning and design.
- **VR-G-2** Project developers shall analyze how the visual values influence project design and how the impacts on these values will be minimized through consideration for the proposed project location and its relationship to the surrounding viewshed.
- **VR-G-3** Project developers shall include a qualified professional, such as a landscape architect, with demonstrated experience with the BLM's VRM policies and procedures as part of the developer's and the BLM's respective planning teams, to evaluate visual resource issues as project siting options are considered.
- **VR-G-4** Project developers, in coordination with the BLM, shall consult with the public—including environmental justice communities—and other interested parties to provide input on identifying important visual resources in the project area and on the siting and design process. Interested parties shall be involved and informed about the visual site design elements of the proposed solar energy facilities.
- **VR-G-5** Project developers shall consult on viewshed protection objectives and practices with the respective land management agencies for landscapes having special designations, including but not limited to Wilderness Areas, National Scenic and Historic Trails, Wild and Scenic Rivers, National Parks, National Monuments, other NLCS units, and National Wildlife Refuges located within the project's viewshed. Developers shall demonstrate a concerted effort to reconcile

conflicts while recognizing that the BLM retains authority for final decisions determining project approval and conditions.

- **VR-G-6** Project developers, in coordination with the BLM, shall conduct outreach through public forums as necessary to disseminate visual resource information through methods such as offering organized tours of operating solar energy development projects, and using simulations in public presentations.
- **VR-G-7** Project developers shall perform visual mitigation planning and design through field assessments, applied global positioning system (GPS) technology, photo documentation, use of computer-aided design and development software, three-dimensional GIS modeling software, and imaging software to depict visual simulations to reflect a full range of visual resource mitigation measures.
- **VR-G-8** Project developers shall perform visual mitigation and impact monitoring to periodically assess compliance with required mitigation, effectiveness of mitigation, and any actions needed to comply with requirements and/or ensure effectiveness.
- **VR-G-9** For applications proposed in locations that include artifacts and remnants of a National Scenic or Historic Trail (including trails under study or recommended as suitable for Congressional designation), located within the viewshed of a National Historic Trail's designated centerline, or including or within the viewshed of a trail eligible for listing on the *National Register of Historic Places* (NRHP) by virtue of its important historical or cultural values and integrity of setting, project developers and the BLM shall evaluate the potential visual impacts on the trail associated with the proposed project; avoid, minimize, and/or mitigate adverse effects through the Section 106 consultation process; and identify appropriate mitigation measures for inclusion as stipulations in the POD.
- **VR-G-10** Project developers shall consider landscape settings observed from a unit of the National Park system, National Monuments, National Historic Sites, National Trails, State Parks, and cultural resources of Tribal concern that may be a part of the historic context contributing to the historic significance of the site or trail.
- **VR-G-11** Project developers shall obtain topographical data of engineering-design quality and use digital terrain mapping tools at a landscape-viewshed scale for project location selection, site planning and design, visual impact analysis, mitigation planning, and design. The digital terrain-mapping tools shall be at a resolution and contour interval suitable for site design and accurate placement of proposed developments into the digital viewshed.
- **VR-G-12** Project developers shall prepare and evaluate visual simulations in accordance with BLM Handbook Manual 8431 and other agency directives, to create spatially accurate and realistic depictions of the appearance of proposed facilities. Simulations shall depict proposed project facilities from key observation points (KOPs) and other visual resource sensitive viewer locations.

- **VR-G-13** If there are no VRM Class allocations to assess conformance with an RMP, the BLM must establish interim VRM classes where a project is proposed and there are not RMP, or Management Framework Plan (MFP) approved VRM Class Objectives (Manual 8400 Sec. 06(A)(3), Manual H-8410-1 (V)(D), and Manual 8431 (II)(B)).
- **VR-G-14** Project developers shall explore and document design considerations for the siting and design of solar facilities, structures, roads, and other project elements to reduce visual dominance in the viewshed and shall conform with the VRM class objectives.

B.19.2 Site Characterization, Siting Design, and Construction

- **VR-C-1** Project developers shall conduct a pre-construction meeting with construction team and BLM or their designated visual/scenic resource specialists, such as a landscape architect, to review and coordinate the project construction VRM mitigation strategy. Final design and construction documents shall be reviewed with regard to the visual mitigation elements, assuring that requirements and commitments are adequately addressed. The review of construction documents shall include, but not be limited to, vegetation clearing and feathering, grading, drainage, and revegetation.

Additional design features to address impacts during this phase of project development are presented in three categories: design features for glint and glare effects, design features for artificial outdoor lighting impacts, and design features to assess and minimize visual dominance.

B.19.2.1 Design Features to Limit Glint and Glare (gg)

- **VR-C-1gg** Project developers shall assess and quantify potential glint and glare effects and determine the potential safety and visual impacts associated with glint and glare using appropriate and commonly accepted software, procedures, and past project examples.
- **VR-C-2gg** Project developers shall have qualified individuals conduct assessments for glint and glare.
- **VR-C-3gg** Project developers shall use screening (such as vegetation, berms, or fabric barriers, consistent with other visual impact mitigation considerations) to limit offsite visibility of glint and glare from solar panel arrays or other facility components.
- **VR-C-4gg** Project developers shall utilize retro-reflective or luminescent markers in lieu of permanent lighting to the maximum extent possible, consistent with safety requirements.
- **VR-C-5gg** Project developers shall limit use of project construction signs to the maximum extent possible, consistent with safety requirements. Beyond those required for basic facility and company identification for safety, navigation, and

delivery purposes, commercial symbols or signs and associated lighting on buildings and other structures shall be prohibited.

- **VR-C-6gg** Project developers shall minimize to the maximum extent possible offsite visibility of all commercial symbols and signs and associated lighting. Necessary signs shall be made of non-glare materials and utilize unobtrusive colors. The reverse sides of signs and mounts shall be painted or coated using a suitable color selected from the BLM Standard Environmental Color Tool to reduce contrasts with the existing landscape. However, placement and design of any signs required by safety regulations must conform to regulatory requirements.
- **VR-C-7gg** Project developers shall consider offsite compensatory mitigation of visual impacts. In some situations, offsite mitigation may serve to offset and/or recover the loss of visual landscape integrity. For example, offsite mitigation could include removing abandoned buildings, reclaiming abandoned mine sites, putting utility lines underground, rehabilitating and revegetating existing erosion or disturbed areas, or establishing scenic conservation easements. Appropriate offsite mitigation will be determined on a project-specific basis in consultation with the BLM.
- **VR-C-8gg** Where offsite glare is unavoidable and project site/offsite spatial relationships favor effective results, project developers shall install fencing with privacy slats or similar screening materials.

B.19.2.2 Design Features to Limit Impacts of Artificial Outdoor Lighting (al)

- **VR-C-1al** Project developers shall assess and quantify potential lighting impacts on the night sky and nocturnal wildlife while providing lighting for hazard marking, safety, and other necessary site needs.
- **VR-C-2al** Project developers shall ensure that qualified individuals conduct assessments for artificial lighting impacts using appropriate and commonly accepted procedures and past project examples.
- **VR-C-3al** Project developers shall produce a detailed lighting plan prepared by a qualified lighting designer that includes all specifications in Section 5.1.1 in BLM Technical Note 457, *Night Sky and Dark Environments: Best Management Practices for Artificial Light at Night on BLM-Managed Lands* (Sullivan et al., 2023).
- **VR-C-4al** Project developers shall use as few lights as possible, except as required to meet the minimum safety requirements, with no lighting serving an aesthetic or advertising function.
- **VR-C-5al** Project developers shall use minimum intensity lighting, except as required to meet the minimum safety requirements.
- **VR-C-6al** Project developers shall select, site, and direct luminaires so that they illuminate only the area needed to support a particular task (e.g., parking, driving, walking, working).

- **VR-C-7al** Project developers shall use luminaires with a BUG (U0) rating (formerly referred to as full-cutoff luminaires) for all permanent lighting, except as required to meet the minimum safety requirements.
- **VR-C-8al** Project developers shall use lighting controls, such as timers, sensors, dimmers, or switches that are available to facility operators, except as required to meet the minimum safety requirements.
- **VR-C-9al** Project developers shall us vehicle-mounted lights rather than permanently mounted lighting for nighttime maintenance activities, consistent with safety requirements. Whenever possible, such vehicle-mounted lighting shall be aimed toward the ground to avoid causing glare and skyglow.
- **VR-C-10al** When accurate color rendition is not required (e.g., roadway, basic security), project developers shall use amber, orange, or red lighting. When whiter light is required for accurate color rendition, it shall be equal to or less than 3000° Kelvin color temperature.

B.19.2.3 Design Features to Assess and Measure Visual Dominance (v)

- **VR-C-1v** Project developers shall determine conformance with VRM class objectives through the use of the BLM contrast rating procedures defined in BLM Handbook Manual 8431. Visual contrast rating and mitigation of visual impacts shall abide by the requirements outlined in the handbook and other BLM directives. Revised project plans and simulations are to be reevaluated by using the contrast rating procedures.
- **VR-C-2v** Project developers shall select KOPs by first determining the extent of the viewshed using the viewshed modeling tools previously cited under VR-G-10. The viewshed modeling shall illustrate the areas from which the proposed facilities may be seen out to 15 mi (25 km). From within the areas, KOPs are to be selected at places where people would be expected: scenic overlooks, roads, trails, campgrounds, recreationally active river corridors, residential areas, etc. For the purpose of conducting a visual contrast rating evaluation, the number of KOPs would be reduced to those that serve as the best representations for demonstrating conformance to the respective VRM class objectives. The BLM shall be consulted on the KOP selections and reserves the right to require additional KOPs including ground truthing to further determine and verify the extent of visual impacts and conformance to VRM class objectives.
- **VR-C-3v** Project developers shall integrate visual design elements into the construction plans, details, drawings, and specifications for the project.
- **VR-C-4v** Project developers shall incorporate facility siting measures to minimize the profile of all facility-related structures to reduce visibility and visual dominance within the viewshed, particularly for facilities proposed within the foreground/middleground distance zone (0–5 mi [0–8 km]) of sensitive viewer locations.

- **VR-C-5v** Project developers shall incorporate visual design elements when planning for vegetation thinning and clearing, grading, revegetation, drainage, and structural measures; minimize vegetation and ground disturbance; and take advantage of existing clearings/surface disturbance.
- **VR-C-6v** Project developers shall minimize visual dominance of projects by siting projects outside the viewsheds of KOPs or by diminishing dominance through maximizing visible separation with distance.
- **VR-C-7v** Project developers shall, to the maximum extent possible, avoid locating facilities near visually prominent landscape features (e.g., landforms and waterfalls) that naturally draw an observer's attention.
- **VR-C-8v** Project developers shall, to the maximum extent possible, avoid visual "skylining" by placing structures, transmission lines, and other facilities away from ridgelines, summits, or other locations where they would silhouette against the sky from important viewing locations; however, consideration shall be given to the potential for increased ground disturbance and other resource impacts.
- **VR-C-9v** Project developers shall, to the maximum extent possible, design linear features (e.g., ROWs and roads) to follow natural land contours rather than straight lines; however, consideration shall be given to the potential for increased ground disturbance and other resource impacts. Project developers shall, to the maximum extent possible, locate linear developments (e.g., transmission lines, pipelines, roads) at the edges of natural clearings or natural lines of transition between vegetation type and topography.
- **VR-C-10v** Project developers shall reduce cut-and-fill for structures and roads by design and location. Retaining walls, binwalls, half bridges, etc., can be used to reduce cut-and-fill but still should respond to the local visual characteristics/setting.
- **VR-C-11v** Project developers shall design and install natural-looking earthwork landforms, or vegetative or architectural screening to minimize visual impacts, considering shape and height of earthwork landforms for adaptation to the surrounding landscape.
- **VR-C-12v** Project developers shall repeat the size, shape, and characteristics of naturally occurring openings in vegetation for facilities, structures, roads, etc.
- **VR-C-13v** Project developers shall collocate electrical collector lines, pipelines, and communication and local utility lines underground to minimize additional surface disturbance where feasible (e.g., along/or within roads or other paths of surface disturbance).
- **VR-C-14v** Project developers shall minimize visual impacts associated with solar energy and electricity transmission projects by choosing appropriate building and structural materials and surface treatments (i.e., paints or powder coatings designed to reduce contrast and reflectivity). A careful study of the site shall be performed to identify appropriate colors and textures for materials; both summer and winter appearance shall be considered, as well as seasons of peak

visitor use. Materials and surface treatments shall repeat and/or blend with the project's backdrop in terms of existing form, line, color, and texture of the landscape. Materials, coatings, or paints having little or no reflectivity shall be used whenever possible

- **VR-C-15v** Project developers shall consider the typical viewing distances and landscape when choosing colors. Appropriate colors for smooth surfaces often need to be two to three shades darker than the background color to compensate for shadows that darken most textured natural surfaces. The BLM Standard Environmental Color Paint Tool (PC01-PC10) and guidance shall be referenced when selecting colors.
- **VR-C-16v** Project developers shall color-treat solar panel/mirror/heliostat backs/supports to reduce visual contrast with the landscape setting.
- **VR-C-17v** Project developers shall match aboveground pipelines' paint or coating to their surroundings.
- **VR-C-18v** Project developers shall utilize nonspecular conductors and nonreflective coatings on insulators for electricity transmission/distribution projects.
- **VR-C-19v** Project developers shall clearly delineate construction boundaries and minimize areas of surface disturbance; preserve vegetation to the greatest extent possible; utilize undulating surface disturbance edges; strip, salvage, and replace topsoil; use contoured grading; control erosion; use dust suppression techniques; and stabilize exposed soils.
- **VR-C-20v** Project developers shall preserve existing rocks, vegetation, and drainage patterns to the maximum extent possible.
- **VR-C-21v** Project developers shall employ brush-beating, mowing, or the use of protective surface matting rather than removing vegetation.
- **VR-C-22v** Project developers shall avoid leaving slash piles in sensitive viewing areas.
- **VR-C-23v** Project developers shall reduce the visual color contrast of graveled surfaces with approved color treatment practices.
- **VR-C-24v** Project developers shall avoid leaving topsoil piles in sensitive viewing areas.
- **VR-C-25v** Project developers shall spread excess cut-and-fill material within project disturbance area and vegetate per approved restoration plan requirements while maintaining natural drainage pathways. Where soil cannot reasonably be spread within project disturbance areas, excess cut-and-fill materials shall be hauled out to minimize ground disturbance and visual impacts from piles.
- **VR-C-26v** Project developers shall remove stakes and flagging from the construction area after completion of construction.

- **VR-C-27v** Project developers shall consider segregating and spreading topsoil from cut-and-fill activities on freshly disturbed areas to reduce color contrast.
- **VR-C-28v** Project developers shall consider mulching and spreading slash from vegetation removal over fresh soil disturbances.
- **VR-C-29v** Project developers shall consider restoration of disturbed soils by use of weed-free native grasses, forbs, and shrubs representative of the surrounding and intact native vegetation composition (where available) and/or using non-native species, if necessary, to ensure successful revegetation.
- **VR-C-30v** Project developers shall consider multiple-color camouflage technology application projects within sensitive viewsheds and with a visibility distance that is between 0.25 and 2 mi (0.40 and 3.20 km).
- **VR-C-31v** Project developers shall consider the appropriate choice of monopoles versus lattice towers for a given landscape setting to further reduce visual impacts. Considering alternative means of access in visually sensitive areas, to preserve the natural landscape conditions between tower locations.
- **VR-C-32v** Project developers shall consider rounded and varied road-cut slopes and the cut-and-fill pitches to reduce contrasts in form and line; encouraging slope cuts to preserve specimen trees and nonhazardous rock outcroppings.
- **VR-C-33v** Project developers shall consider sculpting and shaping natural or previously excavated bedrock landforms when excavation of these landforms is required. For example, percent backslope, benches, and vertical variations may be integrated into a final landform that repeats the natural shapes, forms, textures, and lines of the surrounding landscape. The earthen landform may be integrated and transitioned into the excavated bedrock landform. Sculpted rock face angles, bench formations, and backslope could adhere to the natural bedding planes of the natural bedrock geology. The color contrast from the excavated rock faces may be removed with a reactive color treatment. Native vegetation or a mix of native and non-native species as nurse plants (if necessary to ensure successful revegetation) could be reestablished with the benches and cavities created within the created bedrock formation.
- **VR-C-34v** Project developers shall use existing topography and vegetation as screening or partially screening devices, where site conditions permit.

B.19.3 Operations and Maintenance

- **VR-O-1** Project developers shall maintain revegetated surfaces until a self-sustaining stand of vegetation is reestablished and visually adapted to the undisturbed surrounding vegetation. No new disturbance shall be created during operations without completion of a VRM analysis and approval by the BLM authorized officer.
- **VR-O-2** Project developers shall keep painted and color-treated facilities in good repair and repaint or retreat when the color fades or flakes.

- **VR-O-3** Project developers shall use interim restoration during the operating life of the project as soon as possible after land disturbances.
- **VR-O-4** Project developers shall include dust abatement and noxious and invasive weed control in maintenance activities.

B.19.4 Decommissioning/Reclamation

- **VR-D-1** Project developers shall begin reclamation of the construction site immediately after construction to reduce the likelihood of visual contrasts associated with erosion and invasive weed infestation and to reduce the visibility of temporarily disturbed areas as quickly as possible. Developers shall coordinate with BLM in advance of interim/final reclamation to have BLM or other designated visual/scenic resource specialists, such as a landscape architect, onsite during reclamation to work on implementing visual resource requirements and BMPs.
- **VR-D-2** Project developers shall include treatments, such as thinning and feathering vegetation along project edges, enhanced contour grading, salvaging landscape materials from within construction areas, revegetation requirements (e.g., use of mix of native and non-native species).
- **VR-D-3** Project developers shall design and implement restoration of the project area to predevelopment visual conditions and the inventoried visual quality rating, or to that of the surrounding landscape setting conditions to the maximum extent possible or to conditions agreed upon by the BLM.
- **VR-D-4** Project developers shall remove aboveground and near-ground-level structures. Some structures may need to be removed to a level below the ground surface to allow reclamation/restoration.
- **VR-D-5** Project developers shall contour soil borrow areas, cut-and-fill slopes, berms, water bars, and other disturbed areas to approximate naturally occurring slopes. Contouring to a rough texture would trap seeds and discourage off-road travel, thereby reducing associated visual impacts. Cut slopes can be randomly scarified and roughened to reduce texture contrasts with existing landscapes and aid in revegetation.
- **VR-D-6** Project developers shall utilize native vegetation approved by the BLM field office to establish a composition consistent with the form, line, color, and texture of the surrounding undisturbed landscape, where site conditions permit.
- **VR-D-7** Project developers shall reapply stockpiled topsoil to disturbed areas, where applicable, or using a mix of native and non-native species approved by the BLM field office to ensure successful revegetation.
- **VR-D-8** Project developers shall remove or bury gravel and other surface treatments.
- **VR-D-9** Project developers shall restore rocks, brush, and forest to approximate pre-existing visual conditions.

B.20 Design Features for Water Resources

The following design features have been identified to avoid, minimize, and/or mitigate potential impacts on water resources (e.g., water quality degradation, stream depletion, reduced groundwater levels, pumping-induced land subsidence, reduced drought resilience) from utility scale solar energy development on BLM-administered lands.

B.20.1 General

The project developers shall consult with the BLM through operations and maintenance of the project, employing an adaptive management strategy and modifications, as necessary and approved by the BLM. General design features to address impacts during are presented in five categories: design features (1) for surface runoff effects, (2) for hydrologic impacts, (3) to minimize effects of water use, (4) to minimize impacts on surface water and groundwater ecosystems, and (5) to demonstrate legal availability of water.

B.20.1.1 Design Features for Surface Runoff Effects (ro)

- **WR-G-1ro** The project developers shall identify site surface water runoff patterns and develop measures that prevent adverse impacts associated with project related soil deposition and erosion throughout and downslope of the project site and project-related construction areas. The project developer shall control project site drainage, erosion, and sedimentation related to stormwater runoff. This shall be implemented within a Stormwater Pollution Prevention Plan and incorporated into the POD, as appropriate.
- **WR-G-1ro** Project developers shall conduct hydrologic analysis and modeling to define the 100-year, 24-hour rainfall and the 500-year, 24-hour rainfall for the project area and calculate projected runoff from these storms at the site.
- **WR-G-2ro** Project developers shall identify the location of salt-affected soils on the project site (e.g., those in the Colorado River Basin).
- **WR-G-3ro** Project developers shall demonstrate the project will not increase the potential for offsite flooding, and include provisions for stormwater and sediment retention on the project site.
- **WR-G-4ro** Project developers shall demonstrate compliance with construction stormwater permitting through the EPA or state-run NPDES program (whichever applies within the state).
- **WR-G-5ro** Project developers shall demonstrate compliance with the EPA requirement that any development larger than 20 acres (0.08 km^2) and begun after August 2011 must monitor construction discharges for turbidity concentrations.
- **WR-G-6ro** Project developers shall manage runoff from parking lots, roofs, or other impervious surfaces.

- **WR-G-7ro** Project developers shall maintain natural drainages and pre-project hydrographs for the project ROW to the extent practicable.
- **WR-G-8ro** Project developers shall maintain pre-development flood hydrograph for all storms up to and including the 100-year rainfall event.
- **WR-G-9ro** Project developers shall incorporate environmental inspection and monitoring measures into the POD and other applicable plans to monitor and respond to impacts from stormwater runoff during construction, operations, and decommissioning of a solar energy development, including adaptive management protocols.

B.20.1.2 Design Features for Hydrologic Impacts (h)

- **WR-G-1h** Project developers shall conduct hydrologic study(ies) that demonstrate a clear understanding of the local surface water and groundwater hydrology.
- **WR-G-2h** Project developers shall determine the relationship of the project site hydrologic basin to other basins in the region.
- **WR-G-3h** Project developers shall identify surface water bodies within the watershed of SEZs or individual projects (including rivers, streams, ephemeral washes/drainages, lakes, wetlands, playas, and floodplains) and identifying the 100-year floodplain near the site.
- **WR-G-4h** Project developers shall identify aquifer systems that are hydrologically connected to the project site, areas of groundwater recharge and discharge (including springs and seeps), and phreatophytic vegetation.
- **WR-G-5h** Project developers shall quantify physical characteristics of surface water features, including streamflow rates, stream cross-sections, channel routings, seasonal flow rates, and water quality parameters (e.g., temperature, turbidity, salinity, suspended solids).
- **WR-G-6h** Project developers shall quantify physical characteristics of the aquifers, such as approximate physical dimensions, confined/unconfined conditions, the transmissivity and storativity of the aquifer materials, and groundwater quality parameters (e.g., dissolved solids).
- **WR-G-7h** Project developers shall quantify the regional climate, including seasonal and long-term information on temperatures, precipitation, evaporation, evapotranspiration, and drought severity.
- **WR-G-8h** Project developers shall consult with the U.S. Army Corps of Engineers (USACE) regarding the siting of solar energy generating facilities in relation to hydrological features that have the potential to be subject to USACE jurisdiction.

B.20.1.3 Design Features for Water Use (w)

- **WR-G-1w** Project developers shall coordinate with the BLM and other federal, state, and local agencies early in the planning process in order to identify water

use requirements for the solar energy project, and to secure a reliable and legally available water supply to meet project water needs.

- **WR-G-2w** Project developers shall quantify water use requirements for site characterization, project construction, project operations, and decommissioning.
- **WR-G-3w** Project developers shall meet water quality standards of federal, state, and local authorities (e.g., Sections 303 and 304 of the Clean Water Act [CWA]).
- **WR-G-4w** Project developers shall identify wastewater treatment measures and new or expanded facilities, if any, to be included as part of the facility's National Pollutant Discharge Elimination System (NPDES) permit.
- **WR-G-5w** Project developers shall utilize appropriate water sources with respect to management practices for maintaining aquatic, riparian, and other water-dependent resources.
- **WR-G-6w** Project developers shall incorporate environmental inspection and monitoring measures into the POD and other applicable plans to monitor water use during construction, operations, and decommissioning of the solar energy development (such as water meters to measure volume of pumped water). Based on monitoring results adaptive management protocols may be required.

B.20.1.4 Design Features for surface water and groundwater ecosystems (e)

- **WR-G-1e** Project developers shall avoid, minimize, and/or mitigate impacts on existing surface water features, including streams, lakes, wetlands, floodplains, intermittent/ephemeral streams, and playas; on existing groundwater-dependent ecosystems, including springs and seeps and phreatophytic vegetation; and in adjacent regions resulting from the development.
- **WR-G-2e** Project developers shall comply with all sections of the CWA, including Sections 401, 402, and 404, addressing licensing and permitting issues; Executive Orders (E.O.s) 11988 and 11990 of May 24, 1977, regarding floodplain and wetland management: E.O. 11988, "Floodplain Management" (*Federal Register*, Volume 42, page 26951 [42 FR 26951]), and E.O. 11990, "Protection of Wetlands" (42 FR 26961); and EPA stormwater management guidelines and applicable state and local guidelines.
- **WR-G-3e** Project developers shall submit a jurisdictional delineation for consultation with the USACE, in accordance with the Clean Water Act Section 404, Executive Orders 11988 (Federal Register, Volume 42, page 26951, May 24,1977) and 11990 (Federal Register, Volume 42, page 26961, May 24, 1977), and the revised definition of the Water of the United States (Federal Register, Volume 88, page 61964, September 8, 2023) for avoidance, minimization and compensation proposals.
- **WR-G-4e** Project developers shall submit a USACE permit, nationwide verification, or other approved jurisdiction. This includes identification of a Least Environmentally Damaging Practicable Alternative (LEDPA) within the

environmental analysis. The USACE permit, nationwide verification, or approved jurisdiction letter shall be provided to the BLM prior to a decision.

- **WR-G-5e** Project developers shall comply with National Wild and Scenic Rivers System (Public Law 90-542; 16 *United States Code* [U.S.C.] 1271 et seq.).
- **WR-G-6e** Project developers shall comply with Colorado River Basin Salinity Control Act (Public Laws 93-320, 98-569, and 104-20), where applicable.
- **WR-G-7e** Project developers shall comply with the required CWA Section 303(d) identification of impaired surface water bodies.

B.20.1.5 Design Features to Demonstrate Legal Availability of Water (l)

- **WR-G-1l** Project developers shall perform a water availability assessment to demonstrate that water is physically and legally available to meet the project's needs in accordance with the BLM's sustained yield mission. It is not sufficient to determine groundwater is available for proposed activities based solely upon the long-term average rate of recharge of an aquifer system.
- **WR-G-2l** The water availability assessment conducted by the project developers shall evaluate the potential effects on the availability of water for public land management. At a minimum, the assessment shall consider:
    - Policies, designations, or declarations issued by federal, Tribal, state, and local water management agencies in response to drought and water shortages.
    - Existing consumptive and non-consumptive uses of surface water and groundwater and points of diversion on BLM-administered lands at the relevant landscape scale.
    - The reasonably foreseeable water needs on BLM-administered land in the project area.
    - Sources of water supply to meet the project's needs.

B.20.2 Site Characterization, Siting and Design, Construction

- **WR-C-1** Project developers shall reclaim disturbed soils as quickly as possible.
- **WR-C-2** Project developers shall prevent the release of project waste materials into stormwater discharges.
- **WR-C-3** Project developers shall avoid impacts on sole source aquifers according to EPA guidelines.
- **WR-C-4** Project developers shall develop measures to prevent potential groundwater and surface water contamination and incorporate them into the Spill Prevention and Emergency Response Plan and POD, as appropriate.
- **WR-C-5** Project developers shall minimize land disturbance in ephemeral washes and dry lakebeds. Stormwater facilities shall be designed to route flow

through or around the facility using existing washes when feasible, instead of concrete-lined channels.

- **WR-C-6** Project developers shall design culverts and water conveyances to comply with BLM, state, and local stormwater runoff standards, or to accommodate the runoff of a 100-year storm, whichever is larger.
- **WR-C-7** Project developers shall design stormwater retention and/or infiltration and treatment systems for runoff from storm events up to and including the 100-year storm event.
- **WR-C-8** Project developers shall utilize geotextile matting to stabilize disturbed channels and stream banks, as applicable.
- **WR-C-9** Project developers shall divert worksite runoff from entering disturbed streams using earth dikes, swales, and lined ditches.
- **WR-C-10** Project developers shall place sediment control devices so that sediment-laden water can pond, thus allowing sediment to settle out.
- **WR-C-11** Project developers shall consider placement of check dams (i.e., small barriers constructed of rock, gravel bags, sandbags, fiber rolls, or reusable products) across a swale or drainage ditch to reduce the velocity of flowing water.
- **WR-C-12** Project developers shall consider special construction techniques in areas of erodible soil, alluvial fans, and stream channel/wash crossings.
- **WR-C-13** Project developers shall backfill foundations and trenches with originally excavated material.
- **WR-C-14** Project developers shall dispose of excess excavated material according to state and federal laws.
- **WR-C-15** Project developers shall maintain drilling fluids or cuttings in a manner so as not to come into contact with aquatic habitats. Temporary impoundments for storing drilling fluids and cuttings shall be lined to minimize potentially contaminated water to infiltrate into aquifers or to discharge to surface water bodies.
- **WR-C-16** Project developers shall avoid washing equipment or vehicles in or near streams and wetlands.
- **WR-C-17** Project developers shall construct entry and exit pits in work areas to trap sediments from vehicles so they do not enter streams at stream crossings.
- **WR-C-18** Project developers shall provide for periodic removal of wastewater by a licensed hauler.
- **WR-C-19** Project developers shall avoid the creation of hydrologic conduits between two aquifers.
- **WR-C-20** Project developers shall use herbicides and pesticides within the framework of BLM and DOI policies and standard operating procedures,

including the use of only EPA-registered pesticides/herbicides that also comply with state and local regulations.

- **WR-C-21** Project developers shall transport, store, manage, and dispose of hazardous materials and vehicle/equipment fuels in accordance with accepted best management practices (BMPs) and in compliance with all applicable regulations, and where applicable, the SWPPP.

B.20.3 Operations and Maintenance

- **WR-O-1** Project developers shall monitor water quantity and quality in areas adjacent to or downstream from development areas through the life of the project to ensure that water flows and water quality are protected. Projecy developers shall follow all applicable permit conditions (e.g., NPDES and state-mandated requirements).
- **WR-O-2** Project developers shall treat sanitary and industrial wastewater either on- or offsite to comply with federal, state, and local regulations. Any discharges to surface waters must meet NPDES permit requirements. Any storage or treatment of wastewater onsite must use proper lining of holding ponds and tanks to prevent leaks.
- **WR-O-3** Project developers shall implement monitoring using adaptive management strategies to ensure that long-term water use during operations does not substantially and disproportionately contribute to the long-term decline of groundwater levels or surface water flows and volumes, considering any mitigation measures that have been taken.

B.20.4 Decommissioning/Reclamation

- **WR-D-1** Project developers shall begin reclamation of the project site immediately after decommissioning to reduce the likelihood of water resource impacts from the project site. Developers shall coordinate with the BLM in advance of interim/final reclamation to have the BLM or other designated resource specialists onsite during reclamation to work on implementing water resource requirements and BMPs.
- **WR-D-2** Project developers shall restore the project area to predevelopment water conditions or to the extent acceptable to the BLM.
- **WR-D-2** Project developers shall consider contouring of soil borrow areas, cut-and-fill slopes, berms, water bars, and other disturbed areas to approximate naturally occurring slopes.
- **WR-D-2** Project developers shall feather edges of vegetation to reduce form and line contrasts with the existing landscapes.
- **WR-D-2** Project developers shall salvage and reapply topsoil from all decommissioning activities during final reclamation.

- **WR-D-2** Project developers shall continue groundwater and surface water monitoring activities for a limited period of time, if appropriate given the specific situation.

B.21 Design Features for Wildland Fire (WF)

The following design features have been identified to avoid, minimize, and/or mitigate potential fire risks that could be affected by utility-scale solar energy development on BOM-administered lands.

B.21.1 General

Project developers shall coordinate with the BLM, local governments, and other appropriate fire and emergency management organizations early in the project planning process to determine fire risk and methods to minimize it. Consultation with the BLM shall be maintained throughout operation and maintenance of the project, employing an adaptive management strategy, and making modifications when necessary with BLM approval.

General design features to avoid, minimize, and/or mitigate potential impacts include:

- **WF-G-1** Project developers shall assess the potential for fire risk associated with the proposed project in coordination with the BLM, local governments, and other appropriate fire and emergency management organizations. Developers shall consult existing land use plans and fire management plans, including County Master Plans, as well as county permitting and building codes.
- **WF-G-2** Project developers shall evaluate fire risk as part of the environmental impact analysis for the project and consider options to avoid, minimize, and/or mitigate such risk in coordination with the BLM, fire and emergency management organizations, and local governments.
- **WF-G-3** Project developers shall develop and implement fire management measures that include providing worker training.
- **WF-G-4** Project developers shall assess potential impacts of wildfires to surrounding areas outside of solar development zones, paying close attention to distance from Wildland-Urban Interface zones.
- **WF-G-5** Project developers shall Incorporate key elements to mitigate the potential for fire into a WEAP that is provided to all project personnel prior to entering the project worksite. The WEAP shall be provided on a regular basis, covering multiple resources, to ensure the awareness of key fire mitigation efforts of the project worksite during all phases of the project's life. The information provided in the WEAP shall be reviewed and approved by BLM prior to the issuance of a Notice to Proceed and incorporate adaptive management protocols for addressing changes over the life of the project, should they occur.
- **WF-G-6** Project developers shall incorporate inspection and monitoring measures, including adaptive management protocols, into the POD and other

applicable plans to monitor and respond to fire risk during construction, operations, and decommissioning of a solar energy development.

- **WF-G-7** Project developers shall reduce fuel in and around the project site. Project developers shall treat non-native weed species to reduce fuel loads in the project site before, during, and after.

B.21.2 Site Characterization, Siting and Design, Construction

- **WF-C-1** Project developers shall site and design solar facilities to ensure sufficient room for fire management within the ROW and its facilities to minimize the risk of fire moving outside the ROW and the risk of fire threatening the facility from outside.
- **WF-C-2** Project developers shall consult fire management personnel to determine actions, both active and passive (e.g., vegetation manipulation, limiting flammable material onsite, limiting work during certain weather conditions), that may minimize the need for protective responses by the BLM and state and local fire organizations.
- **WF-C-3** Project developers shall develop and implement measures to integrate vegetation management to minimize the potential to increase the frequency of wildland fires and prevent the establishment of non-native, invasive species on the solar energy facility and its transmission line and roads.
- **WF-C-4** Project developers shall design facility roadways with adequate rock base, turning radii and other design features to allow for all-weather access by fire fighting equipment, as determined by the local fire code authority.
- **WF-C-5** Project developers shall conduct site-specific assessments to account for vegetation type, historical fire patterns, and other additional factors that may affect wildfire activity. Special attention will be given to invasive species, to mitigate their introduction and spread in the site due to increased foot traffic. Development and implementation of a vegetation/weed management plan for the life of the project shall include options for control and monitoring of invasive species. The plan will be reviewed and approved by BLM before implementation.
- **WF-C-**6 Project developers shall include specifications for the type and placement of BESS, where utilized, within the project site. Project developers shall include fire management protocols specific to BESS, and the specific type of BESS being used, in the site's Fire Management Plan. Project developers shall provide BLM with geospatial data and detailed maps of the site plan, including access roads, panel blocks, and BESS.

B.21.3 Operations and Maintenance

- **WF-O-1** Project developers shall manage vegetation through the development and implementation of a weed management plan for the life of the project that includes options for control and monitoring of invasive and noxious species.

- **WF-O-2** Project developers shall clean vehicles to avoid introducing invasive weeds at a solar facility and prior to entering BLM lands.
- **WF-O-3** Project developers shall monitor, report, and eradicate noxious weeds or invasive species within managed areas. Consultation with BLM will identify appropriate eradication measures on a site-specific basis.
- **WF-O-4** Project developers shall educate project personnel on weed identification, methods of weed and invasive species spread, and methods to treat infestations based on a site-specific analysis of historical invasive and native species.
- **WF-O-5**: To prevent encroachments on the Minimum Vegetation Clearance Distances within any transmission line ROWs associated with the project, refer to NERC reliability standard FAC-003-4 Transmission Vegetation Management.

B.21.4 Decommissioning/Reclamation

- **WF-D-1** All design features developed for the construction phase shall be applied to similar activities during the decommissioning and reclamation phases.

B.22 References

B.22.1 References for Ecological Resources

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B.22.3 References for Geology and Soils

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BLM 2007

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Sullivan et al., 2023

Appendix C: Reasonably Foreseeable Development Scenario

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 would be adequate to meet the nation's renewable energy goals and anticipated development.

C.1 Solar Energy Generating Capacity Projections

Estimating the level of future utility-scale solar energy development in the 11-state planning area during the 20-year planning period involves significant uncertainty. The amount of utility-scale solar deployment that may be developed during the planning period depends on many external factors including: Federal and state laws and policies encouraging solar development such as tax credits and direct investment; state Renewable Portfolio Standards; demand for electricity from solar energy facilities located within the planning area; transmission capacity availability; the relative cost of solar compared to other energy sources; and the availability and cost-effective commercial implementation of new and emerging technologies (e.g., battery storage).

The basis for the RFDS in this Programmatic EIS is the DOE's *Solar Futures Study* (DOE 2021) and its companion report on environmental implications, *Environmental and Circular Economy Implications of Solar Energy in a Decarbonized U.S. Grid* (NREL 2022). The *Solar Futures Study* looks at scenarios that achieve a carbon-free power sector by 2050, reflect national renewable energy goals, and account for increased deployment of both wind and solar energy. For example, the U.S. rejoined the Paris Agreement in 2021 with a goal of reducing net greenhouse gas emissions by 50% tor more by 2030. In addition, the U.S. 2021 Long-Term Strategy outlines the goal of achieving economy-wide net-zero GHG emissions by 2050, and 100% carbon pollution-free electricity by 2035 across the U.S. (U.S. Department of State, 2021). Lastly, at the 2023 G20 summit, President Biden and other G20 leaders committed to pursuing efforts to triple global renewable energy capacity by 2030 (The White House 2023).

The *Solar Futures Study* estimates that up to about 1,570 GW of solar energy development across the entire U.S. would be required for the nation to produce about 45% of its total electricity requirements from solar by 2050[1] and that 80–90% of that will be utility-scale solar, with the remainder coming from smaller-scale distributed solar (DOE 2021). While the outlook for future solar development is uncertain, the BLM assumes that trends of increasing solar energy deployment will continue in light of advancing technology and in response to state and federal policies. As described

[1] The remainder of the electricity needed to decarbonize the grid would come mainly from wind energy.

above, national renewable energy objectives include the established goal to achieve net-zero economy-wide GHG emissions by 2050 and recent commitment to pursue efforts to triple global renewable energy capacity by 2030. The PV solar energy projections BLM selected from the *Solar Futures Study* to represent the RFDS are from an aggressive high-electrification development scenario that assumes enhanced electrification of end uses such as motor vehicles and building spaces and water heating (that is, it assumes that these end uses currently powered mainly with fossil fuels would be powered through renewable sources by 2050, and includes the energy required for these uses in its projections). Therefore, the BLM considers the RFDS to represent an upper-end estimate of potential solar energy development in the next 20 years.

In addition to the *Solar Futures Study*, the U.S. Energy Information Administration's (EIA's) *2023 Annual Energy Outlook* (AEO) also offers long-term annual projections of energy supply, demand, and prices through 2050. The AEO includes a reference case and 12 side cases that examine how energy projections may vary under different assumptions. The reference case, which serves as a baseline and is based on current laws and regulations, projects that total solar energy capacity will reach 790 GW by 2045. The side case projections range from 486 GW in a high zero-carbon technology cost scenario to 1,128 GW in a high economic growth and low zero carbon technology cost scenario (EIA 2023). The highest projections estimated by the EIA are 442 GW less than those estimated in the *Solar Futures Study* scenario used as the basis for the RFDS, providing further evidence that the *Solar Futures Study* scenario represents an upper-end solar energy development estimate for 2045. Using an upper-end estimate as the RFDS allows the BLM to conduct a conservative analysis of potential environmental impacts.

C.2 Solar Energy Land Requirements

Utility-scale solar energy generation is anticipated to occur on federal public lands, as well as on Tribal, State, and private lands. Because significant portions of the states in the planning area are public lands administered by the BLM, a significant portion of utility-scale solar development in the 11-state planning area is expected to be on those public lands.

The *DOE Solar Futures Study* and NREL (2022) report provide estimates of the amount of land required to support future U.S. solar energy generation under a high-electrification scenario, by state, out to the year 2050. Use of these estimates of future solar energy development is anticipated to result in a high-end estimate of land requirements for solar energy development over the next 20 years, allowing the BLM to adequately plan for and allocate sufficient lands for solar energy development siting flexibility. The BLM is considering a high-end estimate of land requirements in order to accommodate increased solar energy development that could occur due, for example, to technology advances, improvements in battery storage technology, increased deployment of solar power in comparison to wind power, or policies and laws that could reduce costs for solar energy development. For example, the BLM's proposed rule, *Rights-of-Way, Leasing, and Operations for Renewable Energy*, 88 Fed. Reg. 39726 (June 16, 2023),

which would "reduce acreage rental rates and capacity fees" as provided for in the Energy Act of 2020, could result in increased solar energy development when finalized. This rule is expected to be finalized in 2024.

C.3 Calculating the RFDS

As summarized in Table C-1, a combined total of 174.2 GW of PV solar energy generation is estimated to be developed across a total land area (federal and non-federal) of 1,307,493 acres in the eleven-state planning area by 2045. The overall power generation and land requirements were estimated based on the *Solar Futures Study* high electrification scenario and the NREL (2022) companion report; these studies used the Regional Energy Deployment System (ReEDS) model to generate projections of the amount of development in each state in the planning area.

Due to legislative and executive direction to prioritize renewable energy development on public lands, the analysis assumes that as much as 75% of solar development would be sited on BLM-administered lands, with the remaining 25% on non-BLM-administered lands. This is a conservative assumption that will likely overestimate solar energy development on BLM-administered lands in certain areas, especially in states with a low percentage of BLM-administered lands (such as Washington, where only 1% of the land is administered by the BLM; see Table C-2). However, in other states like Nevada and Utah, more than 75% of the development may occur on BLM-administered lands due to the large percentage of lands within such states that are administered by the BLM.

Table C-1. Estimated Total Utility-Scale PV Solar Development by 2045 for the 11-State Planning Area

State	2045 Total Utility-Scale PV Solar Development (GW)[1]	2045 Utility-Scale PV Solar Development Land Needed (Acres)[2]
Arizona	35.2	264,281
California	69.8	523,679
Colorado	8.0	60,276
Idaho	15.9	119,433
Montana	1.0	7,183
New Mexico	1.9	14,831
Nevada	8.6	64,159
Oregon	9.1	68,517
Utah	7.1	53,057
Washington	12.8	95,708
Wyoming	4.8	36,369
Totals	**174.2**	**1,307,493**

Source: NREL (2022). 2045 values obtained by interpolating between 2040 and 2050 values given in the source.

[1] Amount of PV solar energy development (GW) based on the high-electrification scenario, as evaluated in NREL (2022).

[2] Land area needed (acres) was calculated based on a PV solar land use estimate of 7.5 acres per MW, from NREL (2022).

The *Solar Futures Study* was based on economic optimization and model simulations of the bulk power system and may not have accounted for other factors that could result in higher solar energy development in some states (NREL 2022). Table C-2 presents an estimate of the amount of land required for solar energy development in the 11-state planning area by 2045 (the RFDS), including an estimate of the subset of solar energy development that would be located on BLM-administered lands.

This Draft Programmatic EIS assumes that the RFDS (which is a high-end estimate of the amount of utility-scale solar development across the 11-state planning area through 2045) would be the same both under the No Action Alternative and the Action Alternatives. 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 if it is more difficult for solar developers to identify financially and technologically suitable project locations. However, because the remaining available lands under these alternatives would be in areas more likely to be suitable for solar energy development and/or less likely to present resource conflicts, it is difficult to estimate how the RFDS might change under the action alternatives. Therefore, , although the state-level estimates of BLM-administered land area required as presented in Table C-2 are generally conservative (high-end) estimates of utility-scale solar energy development on BLM-administered lands through 2045, they are considered useful estimates for the purposes of the Solar Programmatic EIS to allow the BLM to evaluate whether lands available for application under the action alternatives would be adequate to support estimated future solar development over the next 20 years.

C.4 Refining the RFDS

The BLM will continue to refine the RFDS in response to public comments or based on other factors. 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 improved information and data are incorporated into modeling projections, and the deployment of emerging technologies occurs in future years, the BLM expects to revisit these needs and potentially revise the estimated GW and acreages of solar development anticipated in each state. Such a revision could decrease the land-base needed for utility-scale solar energy from a state or states as the new technology is implemented. However, the BLM believes it prudent to plan for ample areas to support current and future solar energy siting interests on public land.

Table C-2. 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 (non-DRECP)[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	**697,830**	**326,877**	—	—

Sources: DOE (2021), NREL (2022). Note: this table is identical to Table 2.2-1.

[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 for 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.

C.5 References

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Appendix D: Government-to-Government and Cultural Resource Consultations

Appendix D provides detailed information on the status of government-to-government consultation for this Programmatic EIS for the 11-state planning area. Consultation between the BLM and the Tribes is ongoing, and this Appendix will be updated as much as possible between publication of the Draft and Final Programmatic EIS. Table D.1 lists the Tribes that received letters inviting them to participate in the National Environmental Policy Act cooperating agency process and offering government-to-government consultation.

Table D.1. Tribes Contacted for this Programmatic EIS with Traditional Territory in Solar-Suitable Areas

State	Organization
Arizona	Ak-Chin Indian Community
	Cocopah Tribe of Arizona
	Colorado River Indian Tribes of the Colorado River Indian Reservation, Arizona and California
	Fort McDowell Yavapai Nation, Arizona
	Gila River Indian Community of the Gila River Indian Reservation, Arizona
	Havasupai Tribe of the Havasupai Reservation, Arizona
	Hopi Tribe of Arizona
	Hualapai Indian Tribe of the Hualapai Indian Reservation, Arizona
	Kaibab Band of Paiute Indians of the Kaibab Indian Reservation, Arizona
	Navajo Nation, Arizona, New Mexico, and Utah
	Pascua Yaqui Tribe of Arizona
	Quechan Tribe of the Fort Yuma Indian Reservation, California and Arizona
	Salt River Pima-Maricopa Indian Community of the Salt River Reservation, Arizona
	San Carlos Apache Tribe of the San Carlos Reservation, Arizona
	San Juan Southern Paiute Tribe of Arizona
	Tohono O'odham Nation of Arizona
	Tonto Apache Tribe of Arizona
	White Mountain Apache Tribe of the Fort Apache Reservation, Arizona
	Yavapai-Apache Nation of the Camp Verde Indian Reservation, Arizona
	Yavapai-Prescott Indian Tribe
California	Agua Caliente Band of Cahuilla Indians of the Agua Caliente Indian Reservation, California
	Alturas Indian Rancheria, California
	Augustine Band of Cahuilla Indians, California
	Bear River Band of the Rohnerville Rancheria, California
	Berry Creek Rancheria of Maidu Indians of California
	Big Lagoon Rancheria, California
	Big Pine Paiute Tribe of the Owens Valley
	Big Sandy Rancheria of Western Mono Indians of California
	Big Valley Band of Pomo Indians of the Big Valley Rancheria, California
	Bishop Paiute Tribe
	Blue Lake Rancheria, California

State	Organization
California (*Cont.*)	Bridgeport Indian Colony
	Buena Vista Rancheria of Me-Wuk Indians of California
	Cabazon Band of Cahuilla Indians (Previously listed as Cabazon Band of Mission Indians, California)
	Cachil DeHe Band of Wintun Indians of the Colusa Indian Community of the Colusa Rancheria, California
	Cahto Tribe of the Laytonville Rancheria
	Cahuilla Band of Indians
	California Valley Miwok Tribe, California
	Campo Band of Diegueno Mission Indians of the Campo Indian Reservation, California
	Capitan Grande Band of Diegueno Mission Indians of California (Barona Group of Capitan Grande Band of Mission Indians of the Barona Reservation, California)
	Capitan Grande Band of Diegueno Mission Indians of California (Viejas [Baron Long] Group of Capitan Grande Band of Mission Indians of the Viejas Reservation, California)
	Cedarville Rancheria, California
	Chemehuevi Indian Tribe of the Chemehuevi Reservation, California
	Cher-Ae Heights Indian Community of the Trinidad Rancheria, California
	Chicken Ranch Rancheria of Me-Wuk Indians of California
	Cloverdale Rancheria of Pomo Indians of California
	Cold Springs Rancheria of Mono Indians of California
	Coyote Valley Band of Pomo Indians of California
	Dry Creek Rancheria Band of Pomo Indians, California
	Elem Indian Colony of Pomo Indians of the Sulphur Bank Rancheria, California
	Elk Valley Rancheria, California
	Enterprise Rancheria of Maidu Indians of California
	Ewiiaapaayp Band of Kumeyaay Indians, California
	Federated Indians of Graton Rancheria, California
	Fort Bidwell Indian Community of the Fort Bidwell Reservation of California
	Fort Independence Indian Community of Paiute Indians of the Fort Independence Reservation, California
	Fort Mojave Indian Tribe of Arizona, California and Nevada
	Greenville Rancheria
	Grindstone Indian Rancheria of Wintun-Wailaki Indians of California
	Guidiville Rancheria of California
	Habematolel Pomo of Upper Lake, California
	Hoopa Valley Tribe, California
	Hopland Band of Pomo Indians, California
	Iipay Nation of Santa Ysabel, California
	Inaja Band of Diegueno Mission Indians of the Inaja and Cosmit Reservation, California
	Ione Band of Miwok Indians of California
	Jackson Band of Miwuk Indians
	Jamul Indian Village of California
	Karuk Tribe
	Kashia Band of Pomo Indians of the Stewarts Point Rancheria, California
	Kletsel Dehe Wintun Nation of the Cortina Rancheria (Previously listed as Kletsel Dehe Band of Wintun Indians)
	Koi Nation of Northern California

State	Organization
California *(Cont.)*	La Jolla Band of Luiseno Indians, California
	La Posta Band of Diegueno Mission Indians of the La Posta Indian Reservation, California
	Lone Pine Paiute-Shoshone Tribe
	Los Coyotes Band of Cahuilla and Cupeno Indians, California
	Lytton Rancheria of California
	Manchester Band of Pomo Indians of the Manchester Rancheria, California
	Manzanita Band of Diegueno Mission Indians of the Manzanita Reservation, California
	Mechoopda Indian Tribe of Chico Rancheria, California
	Mesa Grande Band of Diegueno Mission Indians of the Mesa Grande Reservation, California
	Middletown Rancheria of Pomo Indians of California
	Mooretown Rancheria of Maidu Indians of California
	Morongo Band of Mission Indians, California
	Northfork Rancheria of Mono Indians of California
	Pala Band of Mission Indians
	Paskenta Band of Nomlaki Indians of California
	Pauma Band of Luiseno Mission Indians of the Pauma and Yuima Reservation, California
	Pechanga Band of Indians (Previously listed as Pechanga Band of Luiseno Mission Indians of the Pechanga Reservation, California)
	Picayune Rancheria of Chukchansi Indians of California
	Pinoleville Pomo Nation, California
	Pit River Tribe, California (Includes XL Ranch, Big Bend, Likely, Lookout, Montgomery Creek, and Roaring Creek Rancherias)
	Potter Valley Tribe, California
	Quartz Valley Indian Community of the Quartz Valley Reservation of California
	Ramona Band of Cahuilla, California
	Redding Rancheria, California
	Redwood Valley or Little River Band of Pomo Indians of the Redwood Valley Rancheria, California
	Resighini Rancheria, California
	Rincon Band of Luiseno Indians (Previously listed as Rincon Band of Luiseno Mission Indians of Rincon Reservation, California)
	Robinson Rancheria
	Round Valley Indian Tribes, Round Valley Reservation, California
	Yuhaaviatam of San Manuel Nation (Previously listed as San Manuel Band of Mission Indians, California)
	San Pasqual Band of Diegueno Mission Indians of California
	Santa Rosa Band of Cahuilla Indians, California
	Santa Rosa Indian Community of the Santa Rosa Rancheria, California
	Santa Ynez Band of Chumash Mission Indians of the Santa Ynez Reservation, California
	Scotts Valley Band of Pomo Indians of California
	Sherwood Valley Rancheria of Pomo Indians of California
	Shingle Springs Band of Miwok Indians, Shingle Springs Rancheria (Verona Tract), California
	Soboba Band of Luiseno Indians, California
	Susanville Indian Rancheria, California
	Sycuan Band of the Kumeyaay Nation
	Table Mountain Rancheria
	Tejon Indian Tribe

State	Organization
California *(Cont.)*	Timbisha Shoshone Tribe
	Tolowa Dee-ni' Nation
	Torres Martinez Desert Cahuilla Indians, California
	Tule River Indian Tribe of the Tule River Reservation, California
	Tuolumne Band of Me-Wuk Indians of the Tuolumne Rancheria of California
	Twenty-Nine Palms Band of Mission Indians of California
	United Auburn Indian Community of the Auburn Rancheria of California
	Utu Utu Gwaitu Paiute Tribe of the Benton Paiute Reservation, California
	Wilton Rancheria, California
	Wiyot Tribe, California
	Yocha Dehe Wintun Nation, California
	Yurok Tribe of the Yurok Reservation, California
Colorado	Southern Ute Indian Tribe of the Southern Ute Reservation, Colorado
	Ute Mountain Ute Tribe
Idaho	Coeur D'Alene Tribe
	Kootenai Tribe of Idaho
	Nez Perce Tribe
	Northwestern Band of the Shoshone Nation
	Shoshone-Bannock Tribes of the Fort Hall Reservation
	Shoshone-Paiute Tribes of the Duck Valley Reservation, Nevada
Montana	Assiniboine and Sioux Tribes of the Fort Peck Indian Reservation, Montana
	Blackfeet Tribe of the Blackfeet Indian Reservation of Montana
	Cheyenne River Sioux Tribe of the Cheyenne River Reservation, South Dakota
	Chippewa Cree Indians of the Rocky Boy's Reservation, Montana
	Confederated Salish and Kootenai Tribes of the Flathead Reservation
	Crow Creek Sioux Tribe of the Crow Creek Reservation, South Dakota
	Crow Tribe of Montana
	Flandreau Santee Sioux Tribe of South Dakota
	Fort Belknap Indian Community of the Fort Belknap Reservation of Montana
	Kiowa Indian Tribe of Oklahoma
	Little Shell Tribe of Chippewa Indians of Montana
	Lower Brule Sioux Tribe of the Lower Brule Reservation, South Dakota
	Northern Cheyenne Tribe of the Northern Cheyenne Indian Reservation, Montana
	Oglala Sioux Tribe
	Rosebud Sioux Tribe of the Rosebud Indian Reservation, South Dakota
	Sisseton-Wahpeton Oyate of the Lake Traverse Reservation, South Dakota
	Spirit Lake Tribe, North Dakota
	Standing Rock Sioux Tribe of North and South Dakota
	Three Affiliated Tribes of the Fort Berthold Reservation, North Dakota
	Turtle Mountain Band of Chippewa Indians of North Dakota
	Yankton Sioux Tribe of South Dakota
Nevada	Duckwater Shoshone Tribe of the Duckwater Reservation, Nevada
	Ely Shoshone Tribe of Nevada
	Fort McDermitt Paiute and Shoshone Tribes of the Fort McDermitt Indian Reservation, Nevada and Oregon
	Las Vegas Tribe of Paiute Indians of the Las Vegas Indian Colony, Nevada

State	Organization
Nevada *(Cont.)*	Lovelock Paiute Tribe of the Lovelock Indian Colony, Nevada
	Moapa Band of Paiute Indians of the Moapa River Indian Reservation, Nevada
	Paiute-Shoshone Tribe of the Fallon Reservation and Colony, Nevada
	Reno-Sparks Indian Colony, Nevada
	Shoshone-Paiute Tribes of the Duck Valley Reservation, Nevada
	Summit Lake Paiute Tribe of Nevada
	Te-Moak Tribe of Western Shoshone Indians of Nevada (Four constituent bands: Battle Mountain Band, Elko Band, South Fork Band, and Wells Band)
	Walker River Paiute Tribe of the Walker River Reservation, Nevada
	Washoe Tribe of Nevada & California (Carson Colony, Dresslerville Colony, Woodfords Community, Stewart Community, and Washoe Ranches)
	Winnemucca Indian Colony of Nevada
	Yerington Paiute Tribe of the Yerington Colony and Campbell Ranch, Nevada
	Yomba Shoshone Tribe of the Yomba Reservation, Nevada
New Mexico	Jicarilla Apache Nation, New Mexico
	Mescalero Apache Tribe of the Mescalero Reservation, New Mexico
	Ohkay Owingeh, New Mexico
	Pueblo of Acoma, New Mexico
	Pueblo of Cochiti, New Mexico
	Pueblo of Isleta, New Mexico
	Pueblo of Jemez, New Mexico
	Pueblo of Laguna, New Mexico
	Pueblo of Nambe, New Mexico
	Pueblo of Picuris, New Mexico
	Pueblo of Pojoaque, New Mexico
	Pueblo of San Felipe, New Mexico
	Pueblo of San Ildefonso, New Mexico
	Pueblo of Sandia, New Mexico
	Pueblo of Santa Ana, New Mexico
	Pueblo of Santa Clara, New Mexico
	Pueblo of Taos, New Mexico
	Pueblo of Tesuque, New Mexico
	Pueblo of Zia, New Mexico
	Santo Domingo Pueblo
	Zuni Tribe of the Zuni Reservation, New Mexico
	Ramah Navajo Chapter of the Navajo Nation
Oregon	Burns Paiute Tribe
	Confederated Tribes of Siletz Indians
	Confederated Tribes of the Coos, Lower Umpqua, and Siuslaw Indians
	Confederated Tribes of the Grand Ronde Community of Oregon
	Confederated Tribes of the Umatilla Indian Reservation
	Confederated Tribes of the Warm Springs Reservation of Oregon
	Coquille Indian Tribe
	Cow Creek Band of Umpqua Tribe of Indians
	Klamath Tribes

State	Organization
Utah	Confederated Tribes of the Goshute Reservation, Nevada and Utah
	Paiute Indian Tribe of Utah (Cedar Band of Paiutes, Kanosh Band of Paiutes, Koosharem Band of Paiutes, Indian Peaks Band of Paiutes, and Shivwits Band of Paiutes)
	Skull Valley Band of Goshute Indians of Utah
Utah *(Cont.)*	Ute Indian Tribe of the Uintah & Ouray Reservation, Utah
Washington	Confederated Tribes and Bands of the Yakama Nation
	Confederated Tribes of the Chehalis Reservation
	Confederated Tribes of the Colville Reservation
	Cowlitz Indian Tribe
	Hoh Indian Tribe
	Jamestown S'Klallam Tribe
	Kalispel Indian Community of the Kalispel Reservation
	Lower Elwha Tribal Community
	Lummi Tribe of the Lummi Reservation
	Makah Indian Tribe of the Makah Indian Reservation
	Muckleshoot Indian Tribe
	Nisqually Indian Tribe
	Nooksack Indian Tribe
	Port Gamble S'Klallam Tribe
	Puyallup Tribe of the Puyallup Reservation
	Quileute Tribe of the Quileute Reservation
	Quinault Indian Nation
	Samish Indian Nation
	Sauk-Suiattle Indian Tribe
	Shoalwater Bay Indian Tribe of the Shoalwater Bay Indian Reservation
	Skokomish Indian Tribe
	Snoqualmie Indian Tribe
	Spokane Tribe of the Spokane Reservation
	Squaxin Island Tribe of the Squaxin Island Reservation
	Stillaguamish Tribe of Indians of Washington
	Suquamish Indian Tribe of the Port Madison Reservation
	Swinomish Indian Tribal Community
	Tulalip Tribes of Washington
	Upper Skagit Indian Tribe
Wyoming	Eastern Shoshone Tribe of the Wind River Reservation, Wyoming
	Kiowa Tribe of Oklahoma
	Northern Arapaho Tribe of the Winder River Reservation, Wyoming
	Omaha Tribe of Nebraska
	Santee Sioux Nation, Nebraska
	Winnebago Tribe of Nebraska

Appendix E: Ecoregions of the 11-State Planning Area

E.1 Study Area Ecoregions

An ecoregion is defined as an area that has a general similarity of 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 2022a). Ecoregions of the United States as mapped and described by the U.S. Environmental Protection Agency (EPA) are presented here as the basis for describing ecosystems and visual resources to support analysis of affected environment and potential impacts in this Programmatic EIS. The Level III ecoregion classification includes 35 ecoregions covering the 11-state planning area (Figure E-1). The ecoregion descriptions presented here alphabetically were derived primarily from *Primary Distinguishing Characteristics of Level III Ecoregions of the Continental United States* (EPA 2013a), except where noted.

E.1.1 Arizona/New Mexico Mountains

The Arizona/New Mexico Mountains ecoregion occurs in Arizona and New Mexico. Within the 11-state planning area analyzed in the Programmatic EIS, this ecoregion is approximately 27,353,929 acres (110,783 km^2), and the elevation ranges from 1,572 to 11,562 ft (479 to 3,524 m). It is characterized by low-elevation mountains that support vegetation indicative of dry, warm environments. Chaparral is common on lower elevations, while pinyon-juniper and oak woodlands are found on the lower and middle elevations. Open-to-dense ponderosa pine forests predominate at higher elevations, with forests of spruce, fir, and Douglas fir in a few high-elevation areas. The ecoregion includes the urban area of Flagstaff, Arizona. Important land uses include timber production, livestock grazing, wildlife habitat, military use, and recreation.

E.1.2 Arizona/New Mexico Plateau

The Arizona/New Mexico Plateau is located primarily in Arizona, Colorado, and New Mexico, with a small portion in Nevada. Within the 11-state planning area analyzed in the Programmatic EIS, this ecoregion is approximately 36,289,720 acres (146,973 km^2), and the elevation ranges from 2,165 to 11,949 ft (660 to 3,642 m). The ecoregion's landscapes include low mountains, hills, mesas, foothills, irregular plains, alkaline basins, some sand dunes, and wetlands. This ecoregion is a large transitional region between the semiarid grasslands to the east, the drier shrublands and woodlands to the north, and the lower, hotter, less vegetated areas to the west and south. Vegetation communities include shrublands with big sagebrush, rabbitbrush, winterfat, shadscale saltbush, and greasewood; and grasslands of blue grama, western wheatgrass, green needlegrass, and needle-and-thread grass (Chapman et al. 2006). Higher elevations may support pinyon pine and juniper forests. San Luis Lake is fed by regional groundwater and mountain streams. In Colorado, a high water table supports numerous ephemeral lakes, wetlands, springs, and flowing wells (Chapman et al. 2006). The ecoregion includes the urban areas of Santa Fe and Albuquerque. Important land uses

include irrigated farming, recreation, rangeland, wildlife habitat, and some natural gas production.

Figure E-1. Level III Ecoregions in the 11-State Planning Area (Source: EPA 2013b)

E.1.3 Blue Mountains

The Blue Mountains ecoregion is located primarily in Oregon and extends into Washington and Idaho. Within the 11-state planning area, the ecoregion is approximately 17,522,603 acres (70,967 km^2), and the elevation ranges from 750 to 9,900 ft (229 to 3,020 m) (NatureServe 2023a). This ecoregion is a complex of mountain ranges that are generally lower and more open than the neighboring Cascades, Northern Rockies, and Idaho Batholith ecoregions. The region is mostly volcanic in origin. The few higher ranges consist of granitic intrusive and metamorphic rocks that rise above the dissected lava surface of the region. Important land uses include cattle grazing and wildlife habitat.

E.1.4 Canadian Rockies

Within the 11-state planning area, the Canadian Rockies ecoregion is located in Montana and is approximately 4,665,251 acres (18,894 km^2), with elevation ranges from 3,500 to 10,500 ft (1,068 to 3,203 m) (Woods 2002). The region is higher and more ice-covered than the Northern Rockies, and portions are influenced by moist maritime air masses. Vegetation is mostly Douglas fir, Engelmann spruce, subalpine fir, and lodgepole pine in the forested elevations, with treeless alpine conditions at higher elevations. A large part of the ecoregion is in national parks. Important land uses include tourism and wildlife habitat. Forestry and mining occur outside of park lands.

E.1.5 Cascades

The Cascades ecoregion is located in California and extends north into Oregon and Washington. Within the 11-state planning area analyzed in the Programmatic EIS, the ecoregion is approximately 14,543,149 acres (58,900 km^2), and the elevation ranges from 600 to 14,410 ft (183 to 3,885 m) (EPA 2016). This mountainous ecoregion contains steep ridges and river valleys in the west and a high plateau in the east. The landscape includes westerly trending mountain ridges, steeply sloping mountains, and scattered lakes in glacial-rock basins as well as glaciers and year round snowfields on the highest peaks. It includes active and dormant volcanoes. The ecoregion's moist, temperate climate supports extensive coniferous forests, with subalpine meadows occurring at high elevations. Timber management, recreation, and wildlife habitat are major land use activities.

E.1.6 Central Basin and Range

The Central Basin and Range is located in California, Idaho, Nevada, and Utah. Within the 11-state planning area analyzed in the Programmatic EIS, this ecoregion is approximately 76,303,734 acres (309,030 km^2), and the elevation ranges from 1,106 to 13,439 ft (337 to 4,096 m), but with large portions between 4,000 and 9,000 ft (1,219 and 2,743 m). This internally drained ecoregion is characterized by a mosaic of xeric basins, scattered mountains, and salt flats. The topography is characterized by alternating basins and northerly trending mountain ranges. Shrub and shrub/grass

communities, primarily Great Basin sagebrush and saltbush-greasewood, predominate on valleys, lower slopes, and alluvial fans, while juniper-pinyon woodland, mountain brush, and scattered western spruce-fir forests occur on higher elevation mountain slopes (EPA 2013a; Bryce et al. 2003; Woods et al. 2001). Extensive, nearly flat alkaline or saline playas are part of this ecoregion, and tule marshes exist locally, especially along the Great Salt Lake (Bryce et al. 2003; Woods et al. 2001). The region is generally very sparsely populated but has some large urban areas on its periphery, including Carson City and Reno to the west and Salt Lake City to the northeast. Important land uses include rangeland, wildlife habitat, recreation, military reservations, logging, mining, and some irrigated farming.

E.1.7 Central California Foothills and Coastal Mountains

The Central California Foothills and Coastal Mountains ecoregion is located entirely within California. Within the 11-state planning area analyzed in the Programmatic EIS, the ecoregion is approximately 18,946,607 acres (76,734 km^2), and the elevation ranges from 0 to 5,248 ft (0 to 1,601 m). The Mediterranean climate of hot dry summers and cool moist winters is characteristic of this ecoregion. and associated vegetative cover is mainly chaparral and oak woodlands; grasslands occur in some lower elevations and patches of pine are found at higher elevations. Most of the region consists of open low mountains or foothills, and there are some areas of irregular plains and narrow valleys. Important land uses include ranching, cattle grazing, and wildlife habitat. Some valleys are major agricultural centers such as the Salinas or the wine vineyard center of Napa and Sonoma.

E.1.8 Central California Valley

The Central California Valley ecoregion is located entirely within California. Within the 11-state planning area analyzed in the Programmatic EIS, the ecoregion is approximately 11,487,979 acres (45,526 km^2), and the elevation ranges from 0 to 4,337 ft (0 to 1,322 m). The ecoregion is a flat, intensively farmed plain that has long, hot, dry summers and cool winters. Nearly half of the region is cropland, most of which is irrigated. The region once supported an array of prairies, oak-grass savannas, desert grasslands, riparian woodlots, and wetlands; however, human activities have affected most of the native plant communities (Olson and Cox 2001).

E.1.9 Chihuahuan Deserts

The Chihuahuan Deserts ecoregion is located in Arizona and New Mexico. Within the 11-state planning area analyzed in the Programmatic EIS, this ecoregion is approximately 17,907,555 acres (72,526 km^2), and the elevation ranges from 2,854 to 8,038 ft (870 to 2,450 m). The broad basins and valleys of this ecoregion are bordered by sloping alluvial fans and terraces. The central and western parts of the region contain isolated mesas and mountains. Arid grassland and shrubland are the predominant vegetation types. The higher mountains, however, support oak-juniper

woodlands. Important land uses include grazing, ranching, recreation, wildlife habitat, military reservations, and mining.

E.1.10 Coast Range

The Coast Range ecoregion is located along the coast of California and extends north into Oregon and Washington. Within the 11-state planning area analyzed in the Programmatic EIS, this ecoregion is approximately 13,400,720 acres (54,273 km^2), and the elevation ranges from 0 to 5,701 ft (0 to 1,739 m) (EPA 2016). The topography of this ecoregion ranges from beaches and low terraces to steeply sloping capes and volcanic slopes. The original dominant types of vegetation were Sitka spruce and coastal redwood forests along the coast, with a mosaic of western red cedar, western hemlock, and seral Douglas fir in the inland areas. The low Coast Range mountains support highly productive coniferous forests. The area is now widely managed for timber production, and it supports extensive plantations of Douglas fir. Because of the high precipitation levels, there are numerous streams and rivers. High scenic values attract many recreationists. Logging, wildlife habitat, recreation, rural residential, urban residential, and commercial development are important land uses within the ecoregion.

E.1.11 Colorado Plateaus

The Colorado Plateaus ecoregion is located in Arizona, Colorado, and Utah, with a small portion in New Mexico. Within the 11-state planning area analyzed in the Programmatic EIS, this ecoregion is approximately 33,748,531 acres (136,682 km^2), and the elevation ranges from 3,284 to 10,204 ft (1,001 to 3,110 m). This ecoregion is characterized by a rugged tableland topography, with large basins, ridges, spectacular canyons, and colorful geological formations. The ecoregion is heavily visited for recreational purposes. The higher elevations support extensive pinyon-juniper woodlands. Groundcover in these woodlands is sparse and consists of grama and other grasses, forbs, and shrubs, such as big sagebrush and alderleaf cercocarpus (Primm 2001). Lower areas contain saltbrush-greasewood shrublands, typical of hotter, drier areas. Land uses include livestock, some irrigated farming, recreation, mining, wildlife habitat, and gas and oil production.

E.1.12 Columbia Plateau

The Columbia Plateau ecoregion is located in Washington and extends into Idaho and Oregon. Within the 11-state planning area analyzed in the Programmatic EIS the ecoregion is approximately 20,542,146 acres (83,196 km^2), and the elevation ranges from 160 to 5,700 ft. (49 to 1,739 m) (NatureServe 2023b). The Columbia Plateau ecoregion is an arid sagebrush steppe and grassland surrounded by moister, forested mountainous areas. This ecoregion is underlaid by basalt up to two miles deep, and covered in some places by loess soils that have been cultivated for wheat, particularly in the eastern portions of the region where there is more precipitation. Important land uses include livestock, farming, and wildlife habitat.

E.1.13 Eastern Cascades Slopes and Foothills

The Eastern Cascades Slopes and Foothills ecoregion is located in California and extends north into Oregon and Washington. Within the 11-state planning area analyzed in the Programmatic EIS, the ecoregion is approximately 13,160,143 acres (53,299 km^2), and the elevation ranges from 2,015 to 9,348 ft (614 to 2,849 m). This ecoregion, with a dry continental climate, lies in the rain shadow of the Cascade Mountains and supports open forests of ponderosa pine and some lodgepole pine. Plant communities in this ecoregion are adapted to frequent fires. Landscapes range from marshy basins to steeply sloped mountains and volcanic plateaus. The region also contains forests of white fir, sugar pine, and incense cedar; western juniper woodlands; and sagebrush steppe with low sagebrush, Wyoming big sagebrush, and bunchgrasses (Thorson et al. 2003). Important land uses include timber management, recreation, grazing, wildlife habitat, rural residential development, orchards, and cropping in valleys.

E.1.14 High Plains

The High Plains ecoregion is located in Colorado and New Mexico and extends north into Wyoming. Within the 11-state planning area analyzed in the Programmatic EIS, this ecoregion is approximately 28,130,798 acres (113,930 km^2), and the elevation ranges from 2,979 to 7,600 ft (908 to 2,318 m). This ecoregion consists of smooth to slightly irregular plains. Blue grama-buffalo grass prairies dominate the natural vegetation in this region, which also includes sandsage prairie with sand sagebrush, rabbitbrush, sand bluestem, prairie sandreed, and Indian ricegrass (Chapman et al. 2006). Also occurring are bluestem-grama prairie and wheatgrass-bluestem-needlegrass prairie (Cook et al. 2001). Much of this ecoregion comprises cropland. The ecoregion includes the city of Denver. Other important land uses include grazing, wildlife habitat, oil and gas production, and gravel mining.

E.1.15 Idaho Batholith

The Idaho Batholith ecoregion is located primarily in Idaho and extends into Montana. Within the 11-state planning area analyzed in the Programmatic EIS, this ecoregion is approximately 14,896,340 acres (60,330 km^2), and the elevation ranges from 1,400 to 11,000 ft (427 to 3,355 m) (Chapman 2004; McGrath 2002). This ecoregion is a dissected, partially glaciated, mountainous plateau. Many perennial streams with high water quality originate here. Igneous rock is common and soils are sensitive to disturbance, especially when stabilizing vegetation is removed. Land uses include logging, grazing, wildlife habitat, and recreation, with Grand fir, Douglas fir and, at higher elevations, Engelmann spruce and subalpine fir. Ponderosa pine, shrubs, and grasses grow in deep canyons. The maritime influence lessens toward the south of this ecoregion.

E.1.16 Klamath Mountains/California High-North Coast Range

The Klamath Mountains/California High-North Coast Range ecoregion is located in California and extends north into Oregon. Within the 11-state planning area, this ecoregion is approximately 11,949,581 acres (48,396 km^2) and the elevation ranges from 577 to 8,268 ft (176 to 2,520 m). This ecoregion is physically and biologically diverse, with highly dissected, folded mountains; foothills; terraces; and floodplains. The vegetation is a mosaic of conifers and hardwoods. The valleys and foothills support grassland-savanna and grasslands with bunchgrass and wheatgrass, oak woodlands, oak savanna, Douglas fir, ponderosa pine, madrone, and incense cedar (Thorson et al. 2003). Forests composed of tanoak, Douglas fir, port orford cedar, and madrone occur on mountain areas. Seasonal ponds occur on mesa tops. Land uses include logging, grazing, crop and tree fruit production, recreation, rural residential development, mining, wildlife habitat, and some commercial development.

E.1.17 Madrean Archipelago

The Madrean Archipelago ecoregion is located in Arizona and New Mexico. Within the 11-state planning area, this ecoregion is approximately 9,796,929 acres (39,678 km^2) and the elevation ranges from 2,129 to 10,250 ft (649 to 3,124 m). It consists of basins and ranges with medium to high local relief. Native vegetation in the basins is mostly grama-tobosa shrub-steppe. Oak-juniper woodland is the dominant vegetation type on the ranges; however, ponderosa pine is predominant at higher elevations. Land uses include livestock grazing, wildlife habitat, and some mining.

E.1.18 Middle Rockies

The Middle Rockies ecoregion is located in Montana, Idaho, and Wyoming. Within the 11-state planning area, this ecoregion is approximately 38,667,391 acres (156,603 km^2), and the elevation ranges from 3,000 to 12,800 ft (915 to 3,904 m) (Woods 2002). The mountains of the Middle Rockies ecoregion have Douglas fir, subalpine fir, and Engelmann spruce forests as well as some large alpine areas. Foothills are partly wooded or shrub- and grass-covered. Intermontane valleys are grass- and/or shrub-covered and contain a mosaic of terrestrial and aquatic fauna that is distinct from the nearby mountains. Many mountain-fed perennial streams occur, and recreation, logging, mining, wildlife habitat, and summer livestock grazing are common land uses.

E.1.19 Mojave Basin and Range

The Mojave Basin and Range ecoregion is located in Arizona, California, Nevada, and Utah. Within the 11-state planning area, this ecoregion is approximately 31,522,809 acres (127,789 km^2) in size, and the elevation ranges from approximately 243 ft (74 m) in Death Valley, California, to 10,909 ft (3,325 m). It has a warm, temperate climate with little precipitation and includes the Mojave Desert and scattered mountains (Holland et al. 2001; EPA 2002). The ecoregion is rich in endemic ephemeral plants. Creosotebush shrubland is the predominant natural vegetation. Mesquite, creosotebush, allscale,

brittlebush, desert holly, and sagebrush are dominant species at low elevations (Holland et al. 2001); big sagebrush, blackbrush, Mormon tea, yellowbrush, galleta, Indian ricegrass, cheatgrass, and cholla are dominant at elevations of 3,000 to 5,000 ft (900 to 2,000 m); and pinyon, juniper, and oak woodlots dominate at elevations of 4,000 to 7,000 ft (1,000 to 2,000 m) (Woods et al. 2001; Bryce et al. 2003). The ecoregion includes the urban area of Las Vegas. Important land uses include rangeland, wildlife habitat, urban development, military bases, recreation, gravel operations, some pastureland, and some cropland.

E.1.20 North Cascades

The North Cascades ecoregion is located in Washington. Within the 11-state planning area, this ecoregion is approximately 7,510,766 acres (30,419 km^2), and the elevation ranges from 400 to 10,775 ft (122 to 3,286 m) (EPA 2016). The terrain of the North Cascades ecoregion is composed of high, rugged mountains, with the greatest concentration of active alpine glaciers in the conterminous United States. It has a variety of climatic zones, with a dry continental climate in the east and mild, maritime rainforest conditions in the west. It is underlaid by sedimentary and metamorphic rock. Recreation and wildlife habitat are important land uses.

E.1.21 Northern Basin and Range

The Northern Basin and Range ecoregion is located in California, Nevada, and Utah and extends into Idaho and Oregon. Within the 11-state planning area, this ecoregion is approximately 34,643,702 acres (140,307 km^2), and the elevation ranges from 2,500 to 9,961 ft (763 to 3,036 m). Landscapes include dissected lava plains, valleys, rocky uplands, rolling hills, alluvial fans, and scattered mountain ranges. Valleys and other mountainless areas support sagebrush steppe or saltbush communities, while juniper woodlands occur on rugged, stony uplands (Bryce et al. 2003; Woods et al. 2001). Some areas of sagebrush steppe support scattered ephemeral pools. Wetland communities of sedges, rushes, and marsh grasses; playas; and lakes also occur in this ecoregion. The dominant species on ranges at lower and middle elevations are Wyoming big sagebrush, black sagebrush, and cool season grasses, such as bluebunch wheatgrass and Idaho fescue. Douglas fir, subalpine fir, mountain brush, and aspen groves are common at higher elevations, along with black sagebrush or mountain sagebrush, with open grassland on some ridge tops. Livestock grazing, recreation, mining, and wildlife habitat are important land uses, and there is some farming.

E.1.22 Northern Rockies

Within the 11-state planning area analyzed in the Programmatic EIS, this ecoregion is located in Washington, Idaho, and Montana. It spans approximately 20,252,896 acres (82,024 km^2), and the elevation ranges from 2,100 to 10,700 ft (641 to 3,264 m) (McGrath 2002). The Northern Rockies ecoregion is mountainous and rugged. Both the climate and vegetation are often marine-influenced, with Douglas fir, subalpine fir, Englemann spruce, and ponderosa pine as well as western red cedar, western hemlock,

and grand fir occurring in the ecoregion. The Northern Rockies ecoregion is not as high or as extensively snow- and ice-covered as the Canadian Rockies, although alpine characteristics occur at highest elevations and include numerous glacial lakes. Thick volcanic ash deposits occur in large portions. Logging, mining, and wildlife habitat are common land uses.

E.1.23 Northwestern Glaciated Plains

Within the 11-state planning area analyzed in the Programmatic EIS, the Northwestern Glaciated Plains ecoregion is located in Montana and is approximately 23,701,889 acres (95,992 km^2); the elevation ranges from 1,900 to 5,500 ft (580 to 1,678 m) (Woods 2002). This ecoregion is a transitional region between the Northern Glaciated Plains to the east and the Northwestern Great Plains to the west and southwest. The western and southwestern boundary roughly coincides with the limits of continental glaciation. This ecoregion contains a moderately high concentration of semi-permanent and seasonal wetlands, locally referred to as Prairie Potholes.

E.1.24 Northwestern Great Plains

Within the 11-state planning area, this ecoregion is located in Montana and Wyoming and is approximately 49,869,515 acres (201,972 km^2), with elevation ranging from 1,900 to 7,800 ft (580 to 2,379m). The Northwestern Great Plains ecoregion is a semiarid rolling plain of shale, siltstone, and sandstone with occasional buttes and badlands. Rangeland is common, along with spring wheat and alfalfa farming. Native grasslands exist in areas of steep or broken topography. Wildlife habitat is an important land use.

E.1.25 Puget Lowlands

The Puget Lowlands ecoregion is located in Washington. Within the 11-state planning area, the ecoregion is approximately 4,189,406 acres (16,967 km^2), and the elevation ranges from 0 to 2,677 ft (0 to 816 m) (EPA 2016). The Puget Lowlands ecoregion is a broad rolling lowland characterized by a mild maritime climate. It is composed of many islands, peninsulas, and bays in the Puget Sound area. The Olympic Mountains influence precipitation, and Douglas fir, western hemlock, western red cedar, grand fir, red alder, and bigleaf maple are common forest components. Oak woodlands occur in drier areas. Recreation and wildlife habitat are important land uses.

E.1.26 Sierra Nevada

The Sierra Nevada ecoregion is located almost entirely in California, except for a small portion in west-central Nevada. Within the 11-state planning area, the ecoregion is approximately 13,121,963 acres (53,146 km^2), and the elevation ranges from 827 to 13,596 ft (252 to 4,144 m). This deeply dissected ecoregion slopes gently down to the west and drops sharply on the eastern edge. The eastern portion has been strongly glaciated, and it is characterized by high mountain slopes, peaks, ridges, moraines, and lakes. Lower elevations support mostly ponderosa pine in the west and lodgepole pine in the east, with fir and spruce at higher elevations. Alpine conditions exist at the

highest elevations. The Sierra Nevada ecoregion is famous for its scenic resources. In addition, its close proximity to San Francisco and other major urban areas leads to high levels of recreational use. Other land uses include logging, wildlife habitat, rangeland, and woodland grazing.

E.1.27 Snake River Plain

The Snake River Plain is located primarily in Idaho, with portions extending into Oregon and Wyoming. Within the 11-state planning area, the ecoregion is approximately 13,251,404 acres (53,668 km^2), and the elevation ranges from 2,100 to 6,500 ft (641 to 1,983m) (McGrath 2002). The Snake River Plain ecoregion is considerably lower and more gently sloping than its surrounding ecoregions. Water is available for irrigation, so a large portion of the alluvial valleys bordering the Snake River is used for agriculture, with sugar beets, potatoes, alfalfa, and vegetables being the principal crops. Cattle and dairy operations are also common, with wildlife habitat also being an important land use. Most of the plains and low hills in the ecoregion have a sagebrush-grassland vegetation, except for scattered lava fields, which are barren.

E.1.28 Sonoran Basin and Range

The Sonoran Basin and Range ecoregion is located in Arizona, California, and New Mexico. Within the 11-state planning area, this ecoregion is approximately 29,248,205 acres (118,455 km^2), and the elevation ranges from –243 to 6,569 ft (–74 to 2,002 m). This ecoregion includes the Sonoran Desert and scattered low mountains. The climate is slightly hotter than the Mojave Desert to the north. The potential natural vegetation of this arid ecoregion is predominantly creosotebush-bur sage with large areas of palo verde-cactus shrub and giant saguaro cactus. Land uses include grazing, wildlife habitat, agriculture, mining, and recreation.

E.1.29 Southern California Mountains

Located entirely in California, the Southern California Mountains ecoregion is approximately 3,913,616 acres (15,850 km^2), and the elevation ranges from 3 to 10,621 ft (1 to 3,237 m). This ecoregion has a Mediterranean climate of hot, dry summers and cool, moist winters, but because of a higher elevation than adjacent ecoregions, it has slightly cooler temperatures and more moisture. Comparatively dense chaparral and oak woodlands are the predominant vegetation types, along with stands of ponderosa pine. Some grazing occurs, resulting in erosion in some areas. Wildlife habitat is also an important land use.

E.1.30 Southern California/Northern Baja Coast

The Southern California/Northern Baja Coast ecoregion is located entirely within California and covers a sizable portion of the state. Within the 11-state planning area, the ecoregion is approximately 5,174,478 acres (20,957 km^2), and the elevation ranges from 0 to 5,687 ft (0 to 1,735 m) (Griffith 2016). This ecoregion includes coastal and alluvial plains with low hills in the coastal area of southern California. Coastal sage

scrub and chaparral vegetation communities with many endemic species were once widespread before overgrazing, agriculture, and development occurred. The chaparral-covered hills include ceanothus, buckeye, manzanita, scrub oak, and mountain-mahogany, as well as Coast live oak, canyon live oak, poison oak, and California black walnut. A small area of Torrey pine is found near San Diego.

E.1.31 Southern Rockies

The Southern Rockies ecoregion is located in Colorado, New Mexico, Utah, and Wyoming. Within the 11-state planning area, this ecoregion is approximately 36,003,642 acres (145,815 km^2), and the elevation ranges from 5,187 to 13,777 ft (1,581 to 4,199 m). The ecoregion is characterized by high, steep, rugged mountains. Coniferous forest covers much of the region. The lowest elevations are generally grass- or shrub-covered. Low to middle elevations support a variety of vegetation, including Douglas fir, ponderosa pine, aspen, and juniper-oak woodlands. Middle to high elevations are predominantly coniferous forest. The highest elevations have alpine characteristics. Important land uses include timber management, recreation, hunting, wildlife habitat, grazing, mining, and oil production.

E.1.32 Southwestern Tablelands

The Southwestern Tablelands ecoregion is located in Colorado and New Mexico. Within the 11-state planning area, this ecoregion is approximately 29,673,559 acres (120,178 km^2), and the elevation ranges from 3,399 to 8,432 ft (1,036 to 2,570 m). An elevated tableland, this ecoregion supports subhumid grassland and semiarid rangeland. The natural vegetation in this ecoregion is grama-buffalo grass, with mesquite-buffalo grass also occurring in the southeast portion. Midgrass prairie and open, low shrubs occur along the Canadian River. Juniper-scrub oak-grass savanna occurs on escarpment bluffs (Chapman et al. 2006). This ecoregion includes the urban area of Pueblo, Colorado. Land uses include grazing, dry and irrigated farming, and wildlife habitat, with increasing urban and residential development in some areas.

E.1.33 Wasatch and Uinta Mountains

The Wasatch and Uinta Mountains ecoregion is located primarily in Utah and extends into Wyoming and Idaho. Within the 11-state planning area, the ecoregion is approximately 11,291,082 acres (45,729 km^2), and the elevation ranges from 3,645 to 12,921 ft (1,111 to 3,938 m). This ecoregion is composed of high mountains with narrow crests and valleys, bordered in some areas by dissected plateaus and open high mountains. Lower elevation semiarid foothills support pinyon-juniper woodlands, mountain mahogany-oak scrub, and maple-oak scrub; middle elevations support Douglas fir forests, aspen parklands, ponderosa pine, and lodgepole pine; and Engelmann spruce, lodgepole pine, and subalpine fir occur at higher elevations (Woods et al. 2001). Alpine meadows are present above 11,000 ft (3,400 m). Land uses include timber production, seasonal range and livestock grazing, recreation, wildlife habitat, and oil production, with some irrigated farming in mountain valleys.

E.1.34 Willamette Valley

The Willamette Valley ecoregion is located in Oregon, with a small portion extending into Washington. Within the 11-state planning area, the ecoregion is approximately 3,678,079 acres (14,896 km^2), and the elevation ranges from 0 to 2,200 ft (0 to 671 m) (EPA 2016). The Willamette Valley ecoregion contains terraces and floodplains of the Willamette River system, along with hills, buttes, and adjacent foothills. Elevation is lower and the vegetation differs from the coniferous forests of the surrounding ecoregions. It was originally covered by prairies, oak savannas, coniferous forests, extensive wetlands, and deciduous riparian forests, but the ecoregion now contains the bulk of Oregon's population, industry, commerce, and cropland. Productive soils and a temperate climate make it one of the most important agricultural areas in Oregon, along with having important wildlife habitat.

E.1.35 Wyoming Basin

The Wyoming Basin ecoregion is located in Colorado and Utah, and extends north into Wyoming, Idaho, and Montana. Within the 11-state planning area, the ecoregion is approximately 32,785,525 acres (132,785 km^2), and the elevation ranges from 3,700 to 9,538 ft (1,129 to 2,907 m) (Woods 2002). This ecoregion is a broad intermountain basin with rolling plains, mesas, terraces, scattered high hills, and low mountains (Chapman et al. 2006; Woods et al. 2001). The dominant vegetation types are arid grasslands and shrublands supporting bunchgrasses and sagebrush. Well-drained alluvial fans and foothills support sagebrush grasslands (Chapman et al. 2006). Wetlands supporting sedges, rushes, cattails, and marsh grasses occur in poorly drained floodplains, alluvial fans, and terraces (Woods et al. 2001). Important land uses include oil and gas production, coal mining, grazing, wildlife habitat, and some irrigated farming.

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Appendix F: Methodologies and Supplemental Materials for Analysis of Affected Environment and Environmental Effects of Solar Energy Development on Resources

See Appendix F attachment.

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Appendix G: GIS Data Sources and Methodology

G.1 Introduction

Geographic Information Systems (GISs) are used to store, process, analyze, illustrate, and distribute geospatial data, and many of the results and illustrations in this Programmatic EIS were based on geospatial data and GIS analyses. This approach made it possible to rapidly map existing and planned infrastructure, boundaries, land use designations, and sensitive resources across the 11-state scope of this project.

To the extent possible, and in close cooperation with the BLM, this project obtained and used the most authoritative and current geospatial data. These data were systematically organized in their original format with documentation of their sources and also organized and added to a master geospatial database for the project.

G.2 Data Sources and Limitations

Geospatial data comprise vector (point, line, or polygon) and raster (image) coordinates for their geographic locations, grouped by a topic into a layer (e.g., states)., Each feature layer typically has a set of attributes (e.g., name, area, population, etc.). GIS software provides many capabilities to process, query, combine, and map geospatial layers and features. Geospatial data vary in the scale (the level of detail and accuracy) at which they are mapped. Scale and other characteristics (such as how current data are, whether they are complete, whether they are authoritative, etc.) affect the accuracy and reliability of maps and analytical results generated from them. In most cases these details are recorded as metadata stored with each layer. Geospatial data for a particular theme are usually available only at one scale and may not be fully up to date with current conditions. Some widely used themes, such as cities, are available at different scales and coordinate formats, such as point features for general mapping and labeling, and detailed boundary polygons for more detailed mapping and analysis.

G.2.1 Bureau of Land Management GIS Data

Most GIS data used in the project were collected from or provided by the Bureau of Land Management, including:

- BLM and other federal land jurisdictions
- District and field office boundaries
- Areas designated for solar development in BLM resource management plans, Include:
    - Solar Energy Zones
    - Solar Emphasis Areas
    - Dry Lake East Designated Leasing Area
    - Restoration Design Energy Project Areas

- Land management designations, Include:
    - Areas of Critical Environmental Concern
    - Approved Land Use Plan Boundaries
    - Chaco Withdrawal Area
    - Desert Renewable Energy Conservation Plan (DRECP/CDCA) Decision Region
    - DOD Utah Test and Training Range Land Use Plan Moratorium Area
    - Land and Water Conservation Fund Acquisitions
    - Lands with Wilderness Characteristics
    - National Conservation Areas and Similar Designations
    - National Monuments
    - No Surface Occupancy Areas
    - Other Authorized Acquisitions
    - Routes of Planned, Approved, and Under Construction Transmission Lines
    - ROW Avoidance Areas
    - ROW Exclusion Areas
    - Special Recreation Management Areas
    - Visual Resource Management Areas
    - Wilderness Areas
    - Wilderness Study Areas
    - Wild Horse and Burro Herd Management Areas
- Sensitive resources, Include:
    - Back Country Byways
    - Big Game Migration Corridors
    - Environmental Justice Communities
    - Designated Critical Habitat for Various Species
    - Grazing Allotments
    - Greater, Gunnison, and Bi-State Population Sage Grouse Habitat
    - Phosphate Mine Leasing Areas, Use Permit Areas, and Surface Disturbance
    - Potential Fossil Yield Classification
    - Recreation Sites
    - Restoration Landscapes
    - Visual Resource Inventory Areas
    - Wild Horse and Burro Herd Areas
- Exclusion layers specific to the 2012 Solar PEIS

G.2.2 Argonne National Laboratory GIS Data

Argonne National Laboratory developed the following GIS data from available sources that were not directly available as GIS data:

- Native American Culture Areas
- Native American Judicial Boundaries
- Estimated Day-Night Average Sound Levels, by County

G.2.3 State-Level Fish, Park, and Wildlife Department GIS Data

Data from a variety of state-level resource agencies were either provided by the agency or through publicly available sources, Include:

- California Department of Fish and Wildlife
- Colorado Department of Parks and Wildlife
- Montana Department of Fish, Wildlife and Parks
- Nevada Department of Wildlife
- Oregon Department of Fish and Wildlife
- Utah Division of Wildlife Resources
- Wyoming Game and Fish Department

GIS data from these sources include:

- Big Game Corridors
- Big Game Distribution
- Big Game Range
- Big Game Winter Habitat
- Landscape Connectivity

G.2.4 Department of Homeland Security GIS Data

GIS data from this source were obtained from the Homeland Infrastructure Foundation-Level Database, Include:

- Electrical Substations
- Transmission Lines

G.2.5 Department of Defense GIS Data

GIS data from this source include:

- Military Training Routes (Visual, Slow, and Instrument Flight)
- Special Use Airspace
- Aviation Facilities
- Runways

G.2.6 Department of Energy GIS Data

Power plant locations were obtained from this source.

G.2.7 Environmental Protection Agency GIS Data

GIS data from this source include:

- Level III Ecoregions
- Air Quality Nonattainment Areas
- EPA Mandatory Class 1 Federal Areas
- EPA Brownfield Sites (RE-Powering America’s Land)

G.2.8 ESRI GIS Data

ESRI, the vendor of the GIS software used for the project, provides widely used GIS data as a resource. GIS data used in the project from this source include:

- Cities
- County Boundaries
- Continent Boundaries
- Major Roads
- State Boundaries

G.2.9 GIS Data from Multi-Agency Collaborations

Some GIS data are cooperatively developed and shared by multiple organizations. Data from these sources include:

- All American Roads
- Interagency Fire Perimeter History
- Campsites
- Herbaceous Cover Percentage (2021)
- Interagency Fire Perimeters
- Landfire 2020 Elevation, Historical Disturbance, and Slope
- National Scenic Highways
- Recreation Facilities
- Recreation Permit Entrances
- Western Migrations Habitat and Migration Corridors
- Wild and Scenic Rivers

G.2.10 National Park Service GIS Data

GIS data from this source includes:

- National Historic Landmarks
- National Natural Landmarks
- National Registry of Historic Places, including Buildings, Districts, Objects, Sites, and Structures
- National Park Service Boundaries
- Preliminary Good Sky Quality
- Preliminary Points of Entry
- Preliminary Upstream Watershed
- Preliminary Water Erodibility
- Preliminary Wind Erodibility
- National Historic Trails
- National Scenic Trails
- National Recreational Trailheads

G.2.11 National Renewable Energy Laboratory GIS Data

GIS data from this source include:

- Direct Normal Irradiance
- Solar Insolation
- Horizontal Irradiance Multi-year Annual Average

G.2.12 U.S. Forest Service GIS Data

GIS data from this source include:

- USFS Administrative Unit Boundaries
- Lands with Nationally Designated Management or Use Limitations
- Wild and Scenic Rivers

G.2.13 U.S. Fish and Wildlife Service GIS Data

GIS data from this source include:

- Cisco Milkvetch Conservation Areas
- Isleys Milkvetch Conservation Areas
- Penstemon Conservation Areas
- Stage Station Milkvetch Conservation Areas
- Critical Habitat
- Mojave Desert Tortoise Solar Exclusion Areas
- National Wetland Inventory
- Current Range for All Species
- USFWS Special Designations
- Bird Migration Flyways

G.2.14 U.S. Geological Survey GIS Data

GIS data from this source include:

- Landscape Intactness Multiscale Index
- Ungulate Migrations of the Western United States
- Landslide Incidence and Susceptibility
- Physiographic Divisions
- Quaternary Fault and Fold Database
- Earthquake Hazard (peak ground acceleration with 2 percent probability of being exceeded in 50 years)
- Alluvial and Glacial Aquifers
- Principal Aquifers
- Watershed-level Boundaries (HUC-2 and HUC-8)
- Protected Areas Database v3.0

G.2.15 U.S. Department of Agriculture, Natural Resources Conservation Service GIS Data

GIS data from this source include:

- Soil Survey Geographic (SSURGO) Database
- Gridded National Soil Survey Geographic (gNATSGO) Database

G.2.16 Other GIS Data

The following other data were collected from the sources listed:

- Artificial Sky Brightness for North America, Light Pollution Science and Technology Institute
- Important Bird Areas, Audubon
- National Soil Survey Geographic Database, U.S. Department of Agriculture
- Tribal Lands and Subdivisions, U.S. Census Bureau
- Volcanoes thought to have been active in the last 10,000 years, Princeton University

G.3 Methods

G.3.1 Software

ESRI ArcGIS 10.8 Workstation Software was used for the project for geospatial data management, visualization, processing, analysis, and mapping.

G.3.2 Geographic Projection and Acreage Calculations

The Albers Equal Area projection with a central meridian of 144° West, standard parallels of 25° 30’ north and 45° 30’ north, 23° latitude of origin, North American Datum of 1983, and units in meters was used throughout the project geodatabases, west-wide maps, and acreage calculations. This allowed for consistency in acreage values throughout the results.

G.3.3 Locations and Acreages of Available and Excluded Lands Under Each EIS Alternative

GIS was used to map and determine acreages for each alternative considered in the Programmatic EIS using a process to combine over 100 GIS layers needed for the analysis, including:

- State boundaries
- The DRCEP/CDCA Decision Region (omitted from the analysis scope)
- BLM jurisdictions
- Areas previously designated for solar development
- Layers for every mapped exclusion
- Areas with low intactness

- Existing and planned transmission lines
- Slopes over 10%
- Herbaceous cover percentage

The analysis process required each input layer to be comprised of polygons. All source layers having point or line features representing exclusions were converted to polygon features by using the buffer function with a distance of 0.25 miles, including:

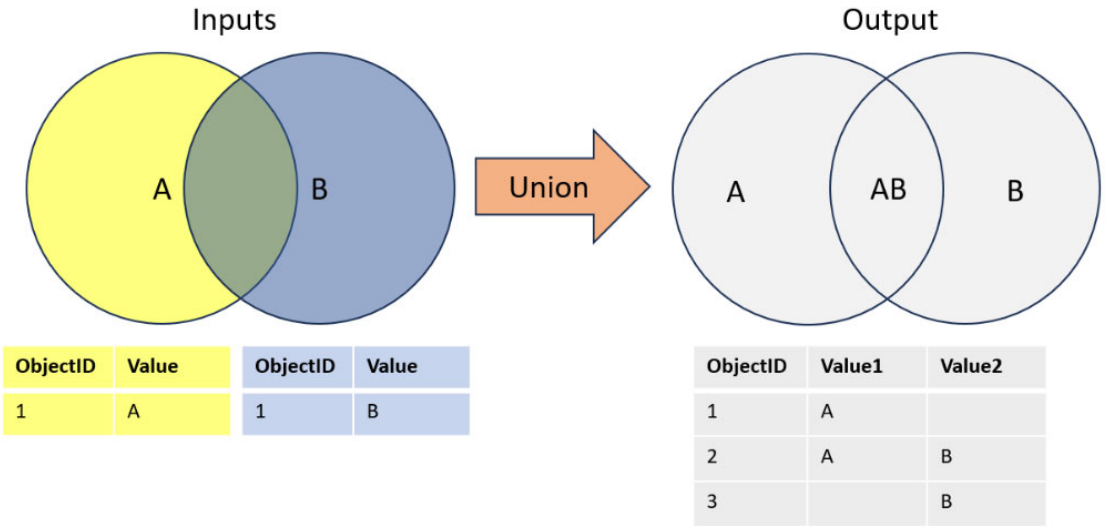
- Critical habitat points
- Campsite points
- Recreation facility points
- National Scenic Trail lines
- National Historic Trail lines
- National Natural Landmark points
- National Historic Landmark points
- Wild and Scenic River lines

Existing and planned transmission lines, and Section 368 Energy Corridors were buffered with a distance of 10.0 miles.

Each input layer was preprocessed to have single-part (non-grouped) features and the "repair geometry" function was used to ensure data quality. All attribute fields were removed from the input layers, except state name from the state layer. For every other layer a single-character field named after the layer was then added and populated with a "Y."

The main step in the process was to use the "union" function to combine all the inputs into one layer. This process subdivides all the unique boundaries of all inputs while preserving their information, resulting in a layer containing all the unique combinations of all inputs. (Figure G.3.1 depicts a conceptual example of the union function for two overlapping circles "A" and "B". The output is three separate non-overlapping areas comprised of "Only A," "AB," and "Only B.")

In the actual analysis over 150 input layers were combined. This layer was post-processed back into single-part features, and "repair geometry" was used to ensure data quality. Any features not on BLM-administered land or outside the 11-state study area were removed. For the action alternatives this resulted in an 11-state layer with over 10,000,000 polygons. The area in acres of each subdivided polygon was then calculated.



ObjectID	Value
1	A

ObjectID	Value
1	B

ObjectID	Value1	Value2
1	A	
2	A	B
3		B

Figure G.3.1. Conceptual diagram of union function.

Next, fields were added to summarize categories based on particular groups of input layers, including resource exclusions, areas within 10 miles of transmission, and slopes over 10%. Then a field for each alternative was added. For each EIS alternative, unique sets of features meeting a particular characteristic were selected and assigned a category until all records were categorized. For example, records falling in the DRECP/CDCA decision area were coded as "DRECP/CDCA," and areas with one or more resource exclusions were coded as "Excluded." etc.

As a final requirement, available parcels needed to be at least 20 acres. However, (1) the areas mapped as excluded or available were different for every alternative, and (2) the layer with all combinations contained many "artificial boundaries" with adjacent polygons having the same category. Therefore, for each alternative the "dissolve" function was used to combine into one parcel any adjacent polygons with the same categorization, resulting in a separate layer for each alternative. The areas of the new features were then recalculated in acres and any polygons smaller than 20 acres were coded as "excluded."

The "summarize" function was used to tabulate total areas by state for each category of each alternative.

G.3.4 Estimates of Potential Effects on Sensitive Resources

Estimates of potential effects on sensitive resources were calculated by intersecting the available lands under each Programmatic EIS alternative with resource-specific GIS datasets and summarizing metrics by state and for the entire 11-state study area. The resource-specific GIS data were also intersected with all BLM lands in the 11-state study area as a means of comparison.

The “intersect” function is similar to the union function, except that only areas overlapping all the inputs are retained. This process subdivides all the unique boundaries of all the inputs while preserving their information, and discarding areas not belonging to all the inputs, resulting in a layer containing all the overlapping unique combinations of all the inputs. Figure G.3.2 depicts a conceptual example of the intersection function for two overlapping rectangles “A” and “B”. The output is one “AB” area.

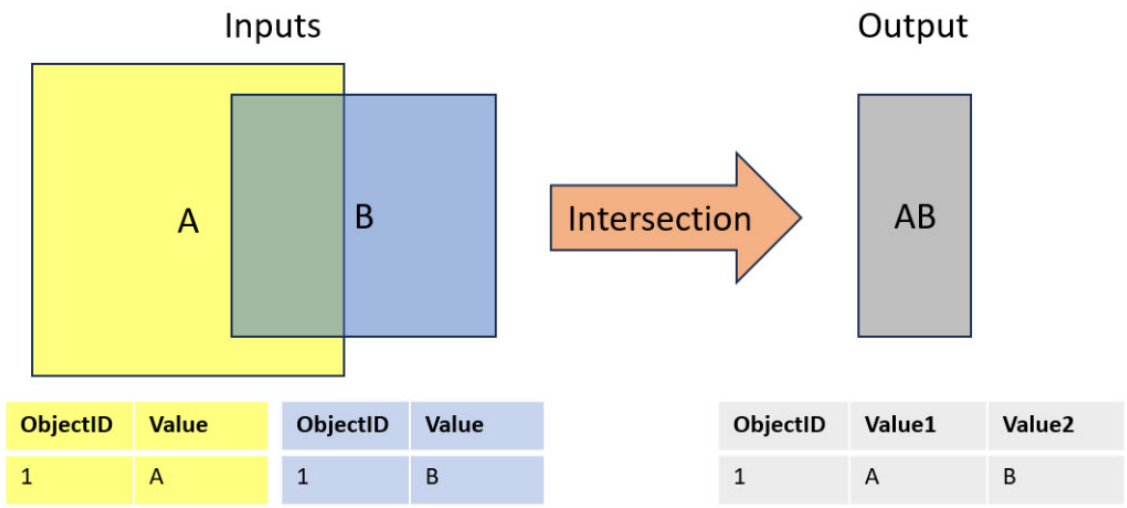


Figure G.3.2. Conceptual diagram of intersection function

Metrics were used to determine effects varied for different resources. For example, for wild horse and burros, the acreages of herd management areas intersecting available lands under each EIS alternative were calculated. For special status species (SSS), the number of species whose ranges intersect available lands was used as a more meaningful metric than acreage because the total range of all SSS covers the entire 11-state study area. Calculations were exported into tables for the Chapter 5 Comparison of Alternatives section.

G.3.5 Mapping

ESRI ArcMap 10.8 was used to create most of the maps in this document.

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Appendix H: Areas of Special Concern

See Appendix H attachment.

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Appendix I: Solar Energy Technology Overview

I.1 Introduction

Solar energy technology can be defined broadly as those activities, applications, or devices designed to harness energy from the sun to perform useful work. Photovoltaic technology began to be advanced in the United States in the 1950s, and the first telecommunications satellite, Telstar 1, was powered by photovoltaic panels in 1962. The first photovoltaic-powered residence was constructed in 1973, and a rapid expansion of solar energy technologies that began in the early 1980s continues today. This overview focuses only on the use of solar energy to produce electric power for utilities by using photovoltaics to convert sunlight directly into electricity.

I.1.1 Scope of Overview

In recent years, technological advances, the rising costs of energy, as well as government regulations and incentives for renewable energy technologies, have increased interest in renewable energy technologies, including solar. This overview does not discuss all variations of energy-producing solar technologies that exist or that could be built. Instead, the scope of this Solar Programmatic EIS is narrowed to focus on photovoltaic (PV, or solar electric), the technology category that is believed to hold the greatest potential for generating large amounts of electricity that can be delivered to the nation's electric grid within the 20-year planning horizon of the Solar Programmatic EIS.

When the Western Solar Plan was developed, there were few operational utility-scale solar energy facilities on BLM-administered lands, and the forecast for future solar energy development suggested that concentrating solar power (CSP) technologies would contribute a substantial share of future solar energy development (BLM 2012). However, in the years since the finalization of the Western Solar Plan, almost all of the solar energy projects on BLM-administered lands have used PV technologies. Based on Table I-3 (discussed in Section I.2), as of December 2022, there has been significant solar energy project development on public lands:

- Seven solar PV projects in operation and two approved projects on BLM-administered lands, each with a capacity less than or equal to 50 MW.
- Sixteen solar PV projects in operation and 11 approved projects on BLM-administered lands, each with a capacity of 51–100 MW.
- No operational solar PV projects with battery storage have been sited on BLM-administered lands, but six such projects have received a ROW grant and are pending operation. The projects range in size from 44 MW to 500 MW.

In total, more than 3,000 MW of nameplate capacity solar energy are in operation on BLM-administered lands, more than 3,500 MW are pending construction, and more than 1,500 MW of solar energy and battery storage projects are pending construction.

I.1.1.1 Technology

Photovoltaic (PV) technology is a solar energy technology that creates electrical power by directly converting the photons in sunlight to electricity. This is called "PV" because it capitalizes on the "photovoltaic effect," which is the ability of certain materials to produce a flow of electrons when excited by sunlight. PV is also referred to as a "solar electric technology." This Solar Programmatic EIS also considers electrochemical battery technology, which can store electricity as chemical potential and then convert that chemical potential back into electricity for export to the grid.

I.1.1.2 Capacity

The scale at which solar PV technology is used to produce electricity can vary greatly and depends on the intended end use of the power being produced. The scope of this Solar Programmatic EIS is limited to solar PV technologies that can produce utility-scale electrical power. The threshold of nameplate capacity used to define utility-scale varies. The EIA provides utility-scale data for any solar facilities with nameplate capacity over 1 MW (EIA 2023), but the applications for ROW grants of leases on BLM-administered lands generally exceed 100 MW. For this Solar Programmatic EIS, utility-scale solar energy development is defined as projects with a nameplate capacity of 5 MW or higher with power transmitted to the grid.

Solar energy technologies that generate electricity used locally to satisfy relatively minor power demands are known as distributed, isolated, or off-grid applications. Some small-capacity installations are not connected to the electric grid, while others—including rooftop PV systems on homes or commercial buildings and small ground-mounted systems—can return excess electricity to the local electric distribution grid. All such applications have relatively low power-generating capacities (typically, a few kilowatts up to a few megawatts), and although they can be very effective and efficient in the individual applications for which they were designed, they are not included in the scope of this Solar Programmatic EIS.

Solar energy technologies by themselves can produce power only when the sun is shining, and power production is related to the intensity of the solar radiation (or insolation) reaching the PV modules (see the *Insolation* section below), among other factors (e.g., temperature, technology). During cloudy periods or at night, power production is severely reduced or stops entirely. Depending on the location and the utility, this intermittent generation can destabilize the electricity grid to which the solar power facility is connected. Various strategies can be employed to mitigate this issue. Use of energy storage is discussed in Section I.3. Other approaches include improved prediction of solar PV output, improved coordination of diverse generating resources, use of solar inverters with advanced control algorithms, enhanced transmission networks, and implementation of market designs, codes, and policies aimed at PV integration (Shafiullah et al. 2022).

I.1.1.3 Insolation

Insolation is the solar radiation that reaches the earth's surface. It is typically represented as energy density and measured in units of watts per square meter (W/m^2) [joules/ft^2] per minute. It represents the total electromagnetic energy contained in the incident sunlight. Factors that affect insolation are the angle of the sun, the distance between the sun and the earth, the duration of daylight, and the transparency of the atmosphere. A measure of insolation at any given location on the earth's surface must account for both daily and annual variations. Changes in insolation levels over the course of the day are expressed as kilowatt hours per square meter per day ($kWh/m^2/day$). This daily average power-generating potential is a more meaningful number for estimating the potential of a location for solar power production. To account for variations in weather (cloud cover and airborne contaminants can both dramatically reduce solar energy reaching the ground), analysis of insolation is typically averaged over multiple years (Figure I-1). Solar technology designers must consider critical factors such as insolation and its variations over the time of day and year at a candidate location. Changes in insolation over time affect both the rate and the characteristics of the power being generated. These impacts can be mitigated by applying devices that can reorient themselves to changing angles of incident sunlight, sophisticated system monitoring capabilities, complex power conditioning equipment, and energy storage systems. However, these features increase initial installation and maintenance costs over a system's lifetime, so compromises are likely to be made that will influence the power-generating capacity of the resulting facility.

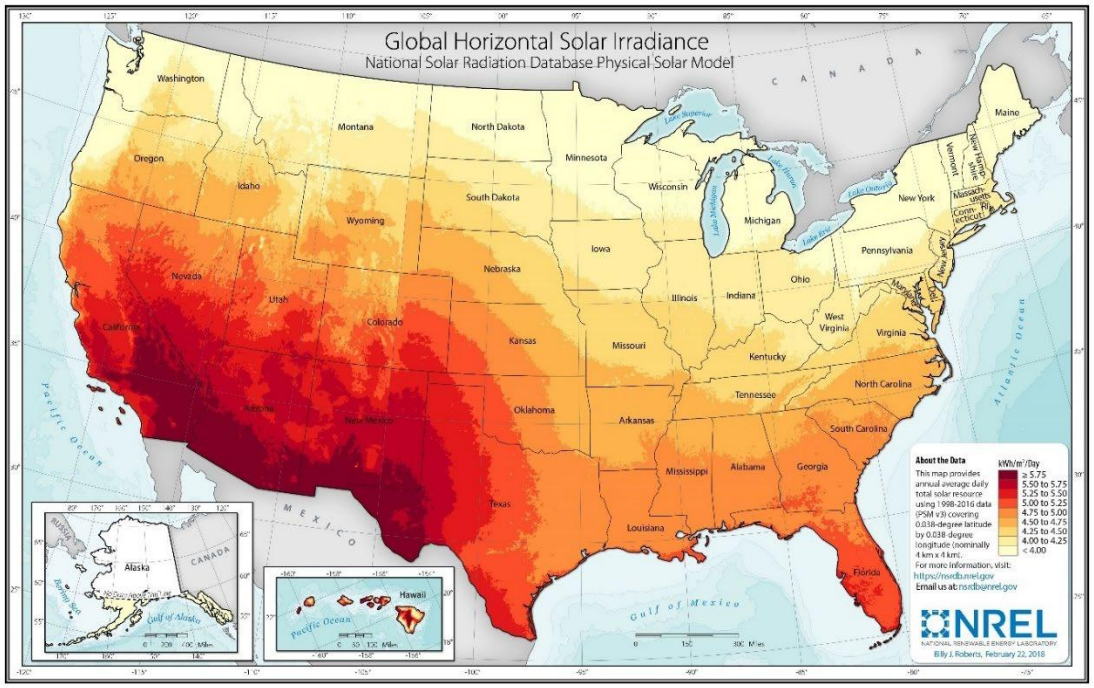

Figure I-1. Annual Average Daily U.S. Total Solar Resource Based on 1998–2016 Data (NREL 2018)

I.1.2 Organization of Overview

Section I.2 provides brief descriptions of solar PV, including:

- How the technology produces electricity and the major components that a facility would need to produce electricity at the utility scale; and
- The current state of commercial solar technology.

A discussion of battery storage technologies is provided in Section I.3.

Section I.4 provides a brief discussion of greenhouse gas impacts.

Solar facilities also will need to connect to the electricity transmission grid. A discussion of required activities for transmission line construction and associated considerations is provided in Section I.5.

I.2 Photovoltaic (PV) Technologies

I.2.1 Overview of PV Technologies

I.2.1.1 PV Effect, Semiconductors, and the Solar Cell

The heart of PV technology is the solar cell that can generate electricity by a physical process known as the photovoltaic effect. French physicist Edmund Becquerel discovered the photovoltaic effect in 1839 when, during experiments with electrolytic cells, he noticed that certain materials could generate small amounts of electric current when exposed to sunlight. Materials exhibiting these unique properties are known as semiconductors.

Metals like copper and iron share a unique physical property: in their solid form, the bonding electrons (electrons in each atom's outermost shells) that hold the atoms together are relatively free to move about in the metallic crystalline lattice and are easily displaced by other electrons introduced into the lattice. Because electricity is the flow of electrons, this property allows metals to act as excellent conductors of electrical current. Atoms such as carbon, silicon, and germanium in their pure crystalline forms hold all their bonding electrons tightly in covalent bonds and resist or impede the flow of electrical current, acting instead as insulators. However, introducing minute amounts of impurities (called dopants) can result in dramatic changes in behavior.

Two types of dopants can be introduced to create semiconductors: negative-type (N-type) and positive-type (P-type). Atoms such as phosphorus or arsenic have five electrons in their outmost shell. Crystallizing a mixture of silicon with a few atoms of phosphorus or arsenic results in a crystal lattice in which one bonding electron of each phosphorus or arsenic atom has nothing to bond with and is thus relatively free to be displaced. Because electrons have a negative charge, the material is known as an N-type semiconductor. Unlike pure silicon, this material conducts electricity, although not as efficiently as would a pure metal; thus, it is referred to as a "semiconductor."

Doping silicon with atoms having only three electrons in their outermost shell (e.g., boron or gallium) results in "holes" in the crystalline lattice (i.e., spaces that are deficient in electrons). Resulting materials are also capable of acting as semiconductors, not by being a source of electrons but by accepting electrons introduced from outside the crystalline lattice. Such materials are identified as P-type semiconductors.

By themselves, neither N-type nor P-type semiconductors are very remarkable or have much practical application. However, in combination they can produce electric current. The simplest configuration of a solar cell combines an N-type semiconductor with a P-type semiconductor, creating an interface or junction where the two meet. Some portion of the energy in sunlight striking this semiconductor pair is absorbed by the "extra" electrons in the N-type semiconductor that are not engaged in bonding. In their excited energy state, those electrons are free to escape from the semiconductor's crystalline lattice and be replaced by other electrons from outside the N-type crystalline lattice. At the same time, the "holes" of electron deficiency in the P-type semiconductor are ready to accept electrons. In combination, an electric field is established at the junction of the semiconductor pair that can provide a flow of current when that field is connected to a load (i.e., an electrical device that can receive the flow of electrons to perform useful work). The N-type semiconductor provides a source of electrons to the load, while the "holes" in a P-type semiconductor realign to receive electrons from the load, thus completing the circuit. Figure I-2 shows a schematic of PV cell operation.

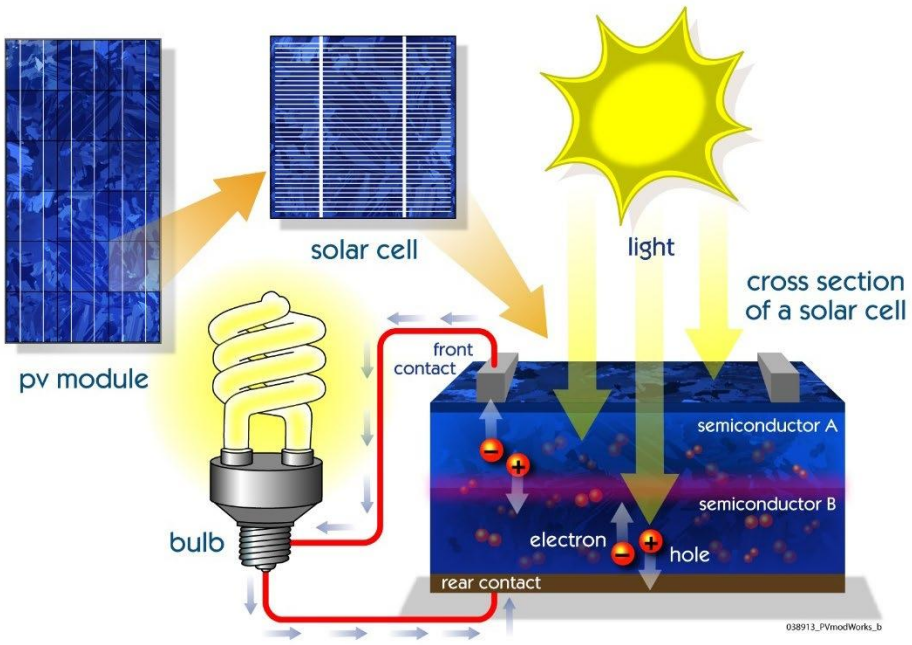

Figure I-2. Schematic of PV Cell Operation

A wide variety of materials exhibit semiconductor properties. Silicon, the second most abundant material in Earth's crust (after oxygen), was one of the first materials used to manufacture semiconductors and is the primary constituent of PV semiconductors produced today. Other semiconductor materials used for solar cells include cadmium telluride, copper indium diselenide, gallium indium phosphide, and gallium arsenide. Selecting the appropriate semiconductor material for solar energy applications is based on the semiconductor's physical and electronic properties:

- Its degree of crystallinity, which influences its sunlight-to-electricity conversion efficiency;
- The amount of sunlight that can be absorbed by a given thickness of material (its absorptivity);
- The range of wavelengths in the sun's light spectrum that can be absorbed (the band gap);
- More practical factors, such as the cost of production (primarily reflected in the cost and availability of raw materials, some of which are rare);
- Its reliability and durability as part of a PV module; and
- The complexity of the manufacturing process.

Solar cells composed of only one semiconductor pair have a practical limit to their conversion efficiency of no more than about 30%, because the single material can capture and efficiently use only a small portion of the sun's light energy spectrum. To date, the best single-crystal silicon research cells have exhibited efficiencies around 27% under normal (non-concentrated) sunlight conditions (NREL 2023).

To increase a solar cell's absorption of sunlight and electric conversion efficiency, semiconductors responsive to photons of different energy can be stacked together in a multijunction solar cell "sandwich." Solar cells composed of two semiconductors (called "two-junction" or "tandem" cells) can theoretically capture as much as 50% of the incident solar flux (Wu et al. 2002). To date, the best two-junction cells have exhibited efficiencies around 33% under normal (non-concentrated) sunlight conditions (NREL 2023). Although it is hypothetically possible to capture 100% of the sun's light energy by stacking enough semiconductors together to capture the entire electromagnetic spectrum of sunlight, in practice there are limits. The increased opacity of multijunction cells, optical losses due to reflection or refraction, as well as the complexity and cost of production, have limited multijunction solar cells to a maximum of three or four semiconductor pairs and a real-world efficiency limit of 70%.

I.2.1.2 Solar Component Fabrication

Fabrication of solar components involves various complex processes. Although fabrication activities are outside the scope of this Solar Programmatic EIS because they would occur at remote manufacturing locations and not at the PV installations being considered, some background information is given here to assist in understanding the design and performance of PV facilities.

Monocrystalline (single-crystal) silicon is the most common utility-scale cell technology deployed in the United States and the world today (Mints 2023). Figure I-3 illustrates the major steps in crystalline silicon PV module production. First, metallurgical grade silicon—refined from quartz deposits—is refined further to produce polysilicon, which for PV applications is typically at least 99.999999% pure silicon. Polysilicon is melted and formed into large ingots, which are sliced very thinly to form wafers. A series of wet chemical treatments, gaseous diffusions, coating depositions, and metallization steps turns wafers into cells. Finally, multiple cells are connected and packaged together inside modules.

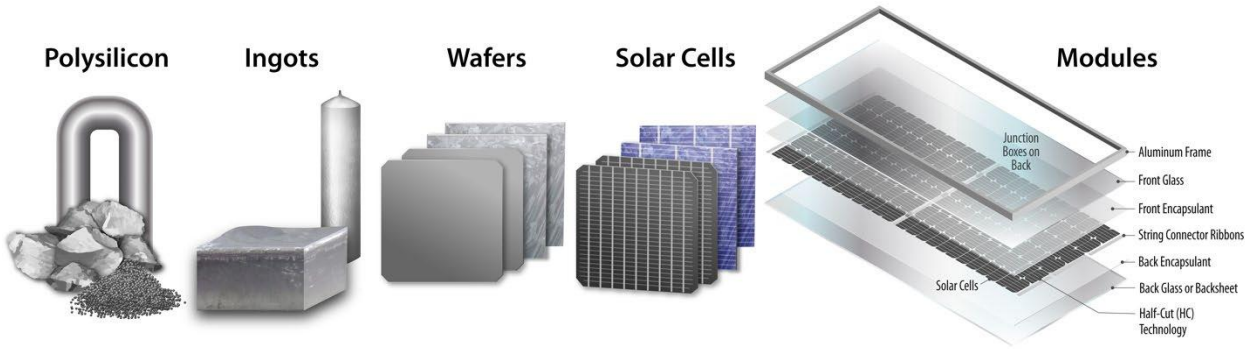

Figure I-3. c-Si Components from Polysilicon to Modules (Basore et al. 2022)

After accounting for crystalline silicon technology, thin-film CdTe technology constitutes essentially all the remaining PV deployed for electricity grids in the United States and worldwide today. Other types of technologies that have been deployed in the past (e.g., multicrystalline silicon, thin-film CIGS) are now deployed minimally or not at all (Mints 2023). Figure I-4 shows an example of the materials and processes used in manufacturing CdTe modules. The CdTe process is much more integrated than the crystalline silicon process, because materials are typically deposited directly onto the module glass.

I.2.1.3 PV System Design Considerations

Crystalline silicon remains the dominant PV technology in the United States and worldwide for several reasons. Most of the materials used in crystalline silicon PV—including silicon used in the semiconductors—are benign, abundant globally, and have demonstrated long-term durability (DOE 2021, Basore et al. 2022). The installed cost of utility-scale PV systems based on crystalline silicon has plummeted, including an 80% reduction in U.S. costs between 2010 and 2022 (NREL 2023). At the same time, global silicon PV manufacturing and deployment have soared, providing the scale to impact electricity generation significantly while helping drive cost reductions (Basore et al. 2022, IEA 2022).

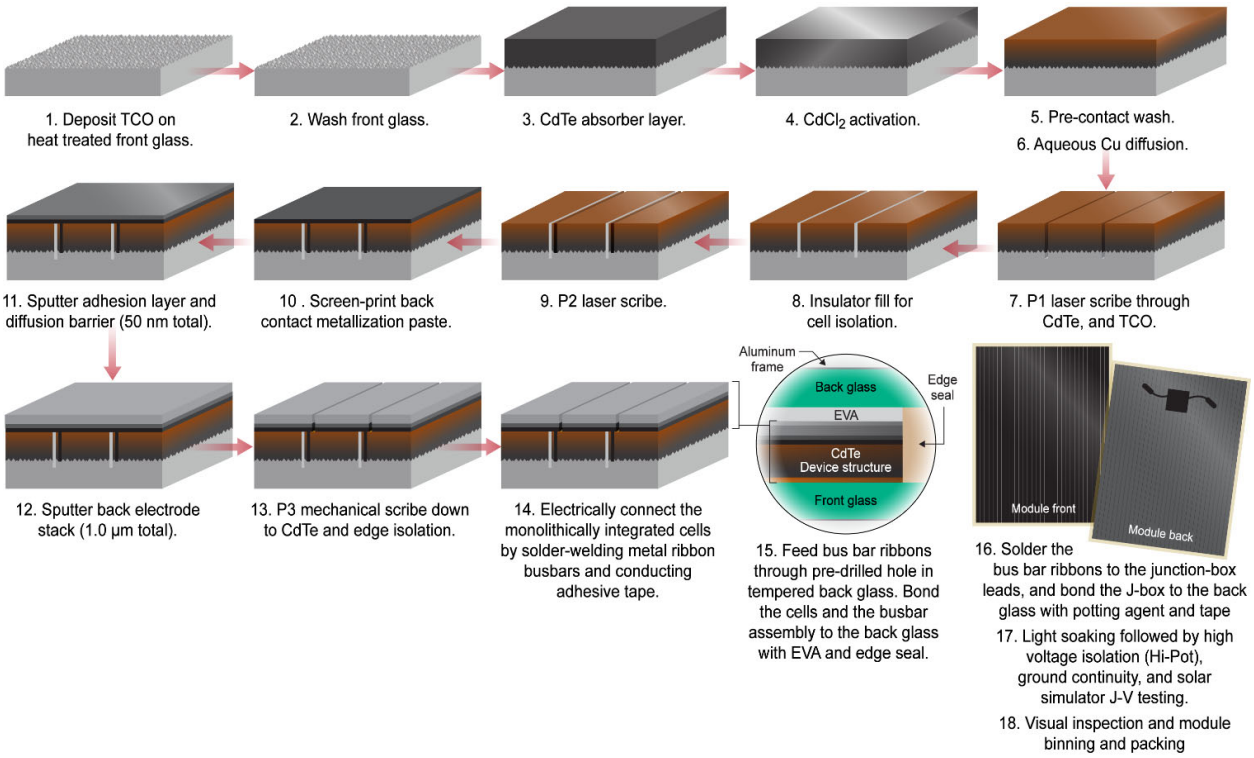

Figure I-4. Typical Process Flow for Making CdTe Modules (Basore et al. 2022)

However, crystalline silicon technology entails disadvantages as well. Companies in China and others with close ties to China dominate every step in the global crystalline silicon supply chain, hosting more than 80% of global production capacity for polysilicon and modules plus more than 90% of production capacity for ingots, wafers, and cells (Feldman et al. 2023). The unpredictable United States–China trade relationship as well as restrictions on Chinese PV products tied to human rights violations have disrupted the supply of crystalline silicon PV to the United States, and the risk of disruption continues (Basore et al. 2022). Although most materials used in crystalline silicon PV are abundant, silver supply could become a constraint if global PV deployment reaches very high levels and strategies to reduce silver use are not employed (DOE 2021, Basore et al. 2022). Finally, the efficiency of single-junction crystalline silicon has risen substantially over the past decade (Feldman et al. 2023), but it is approaching its theoretical limits, which could limit the cost-reduction potential of this technology going forward (see Section I.2.1.1).

Crystalline silicon likely will remain the dominant PV technology deployed in the United States through 2035 as the nation pursues rapid decarbonization (Basore et al. 2022). Still, other PV module technologies have potential to contribute to the United States and global markets over the near and long term. In fact, CdTe modules accounted for 34% of utility-scale PV capacity installed in 2022 (Feldman et al. 2023). Table I-1 summarizes the current status of several technologies and their future potential.

Table I-1. PV module technology current and projected market share and efficiency

Technology	Market Share in 2022: Global/U.S. (%)	Efficiency in 2022: Global (%)	Market Share in 2030: Global (%)	Efficiency in 2030: Global (%)
Crystalline silicon	97/79	21–23	94	23–24
CdTe	3/21	19	6	*
Tandems	†	†	†	27
Perovskites	‡	‡	‡	‡

The global market share values are from (PV Tech 2023). The U.S. market share values are based on U.S. EIA data, as analyzed in Feldman et al. (2023); note that CdTe modules are used almost entirely in utility-scale applications in the United States. The global efficiency values are from ITRPV (2023).

*No efficiency projections for CdTe modules were available.

† Modules based on tandem (two-junction) cells were not commercialized as of 2022. Based on ITRPV (2023), modules with tandem cells will enter the market after 2025 and reach 2% market share in 2030, at which time they will be 27% efficient.

‡ Perovskites are a class of materials with specific crystalline structures, which may provide cost and performance benefits if they can be developed to commercial maturity. Modules based on perovskite materials were not commercialized as of 2022, and no information was available about future market shares or efficiency of this technology.

I.2.2 PV Technologies and Facilities

I.2.2.1 PV Systems

Utility-scale PV systems are made up of PV modules along with various balance-of-system (BOS) components (Figure I-5). PV systems can also be combined with energy storage systems (see Section I.3). Table I-2 describes the basic BOS components for a typical PV facility. The most critical component from the perspective of the transmission grid operator is the power conditioning system (PCS). PV cells produce direct current (DC) electricity. That power must be converted to alternating current (AC) by an inverter. The remaining equipment in the PCS is functionally identical to power conditioning and management equipment found at any thermoelectric power plant but has special design features to accommodate the unique character of the power. Importantly, all PCSs are equipped with devices that can sense grid-destabilizing events and faults and automatically disconnect the PV facility from the grid.

In the past, a large proportion of U.S. utility-scale PV systems were mounted at a fixed tilt. However, since 2015, most utility-scale systems have used single-axis tracking systems. These tracking systems move the modules throughout the day to increase solar generation per module, and they provide favorable economics compared with fixed-tilt systems in most of the United States. In 2021, 90% of all new utility-scale capacity in the United States used tracking (Bolinger et al. 2022).

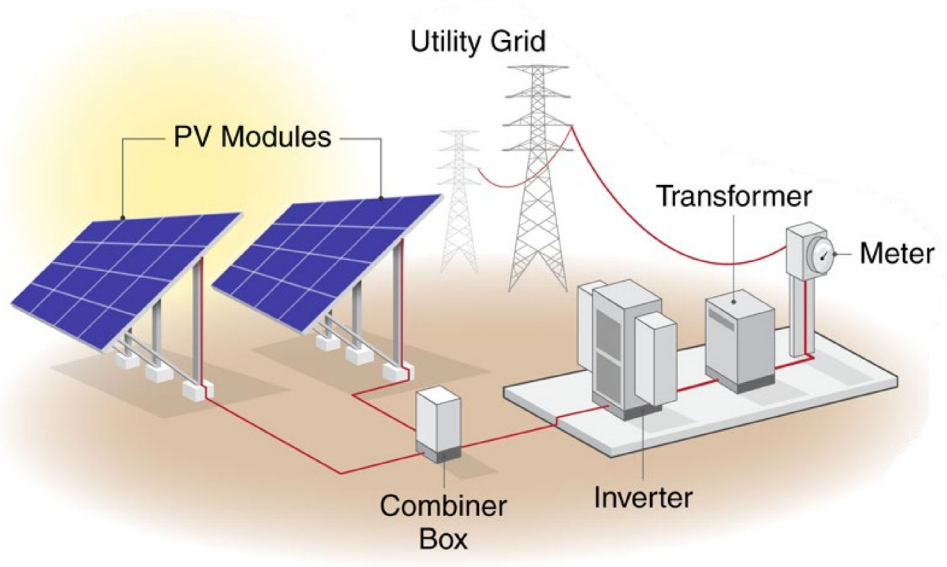

Figure I-5. Illustration of a Utility-scale PV System (Basore et al. 2022)

Table I-2. Select Balance of System Components for PV Facilities

Component	Function	Notes
Electrical cables	Deliver power from individual PV module assemblies to a PCS within the facility and then to a grid.	Can be located above or below ground.
Solar module mounting assemblies	Secure solar modules at the appropriate angle to incident sunlight.	Often of complex designs to adjust for land surface slopes and irregularities; constructed of suitable materials to resist the vagaries of weather over the lifetime of the facility.
Solar module tracking assemblies	Change the orientation of the solar module assembly to improve incident solar radiation.	Single-axis tracking systems are used. Trackers require firm footings (piles, pylons) in the ground. Tracker systems are mostly made of steel components, but also include motors, sensors, and other electrical equipment.
SCADA systems	Remotely monitor system performance, control module assembly tracking features, engage or disengage hybrid system components, monitor power conditioning, and make adjustments to operating parameters in response to upset or changing conditions.	Typically consisting of various solid-state monitoring and control devices, remotely controlled switches and motors, and communication systems (telephone, optic cable, radio, microwave) connecting the facility with a remote control center.
Power conditioning system (PCS)	Convert the DC electricity produced at the modules to AC with inverters. Transformers step up the voltage, and electronics are used to synchronize the phase of the current before connecting it to the transmission grid.	Typically, many strategically located PCSs would be required. Each PCS would also be equipped with various switches, capacitors, and other electrical devices designed to protect the reliability of the transmission grid.
Module cleaning system	Keep surfaces of the solar cells free of dust. Systems can be manual (e.g., spraying from water trucks) or built in.	To avoid scale build-up on the PV module's surface, water for cleaning must be demineralized before use. Recovery of wash solutions may or may not be practical, depending on arrangement of the PV modules.

Component	Function	Notes
Grounding system	Provide personnel safety, lightning protection, reduction of static charge buildup, and electrical surge protection.	Typically composed of strategically placed copper grounding rods or metallic grounding nets buried beneath the ground surface.
Drainage system	Remove rain and cleaning water from site via trenches and/or pipes.	

I.2.2.2 Utility-Scale PV Facilities

Deployment of utility-scale PV—alone and in conjunction with battery storage—is expected to surge in the United States as part of the transition toward a decarbonized grid. Figure I-6 shows historical U.S. deployment during 2020–2022, proposed deployment for 2023–2024, and projected deployment through 2035. Annual U.S. utility-scale PV installations ranged from 11–14 GW in 2020 through 2022. Utility-scale PV capacity proposed by project developers totals about 24 GW in 2023 and 36 GW in 2024 (EIA 2023b, EIA 2023c). Table I-3 includes information about utility-scale PV power plants on BLM-administered lands with a peak capacity of greater than 5 MW.

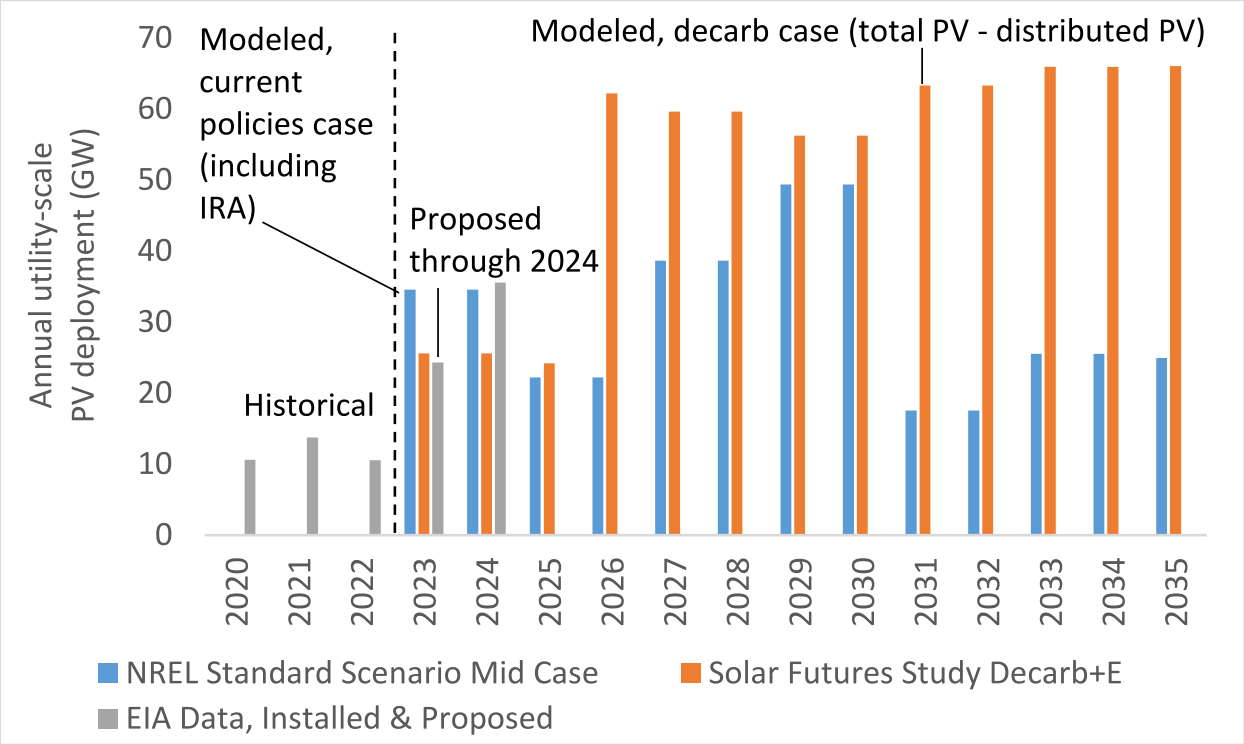

Figure I-6. Annual Utility-scale PV Deployment in the United States: Historical, Proposed, and Projected

Table I-3. Summary Information for Existing and Proposed Utility-Scale PV and PV-Plus-Storage Plants on BLM-Administered Land[1] (BLM 2023)

Plant Name	County	State	Capacity (MW)	Plant area (acres)	Notes
Arica Solar Project	Riverside	California	265	2,000	• PV + storage • ROW grant issued December 2021. Final Notice to Proceed for full construction issued June 2022 • Pending construction
Arlington Solar Energy Center	Riverside	California	500	2,180	• PV + Energy Storage System • Previously McCoy Solar Energy Project (MSEP) Unit 2 Project • ROW grant issued August 2014 • Pending construction
Aurora Solar	Kern	California	44	233	• PV + storage • ROW grant issued May 2020 • Pending construction
Blythe	Riverside	California	235	4,518	• PV • ROW grant issued November 2010 • Operational since 2016
Crimson Solar	Riverside	California	350	2,500	• PV • Record of Decision to authorize a ROW issued May 2021 • Pending construction
Desert Harvest	Riverside	California	150	1,412	• PV • ROW grant issued in September 2013 • Operational
Desert Harvest II	Riverside	California	70	490	• PV • ROW grant issued in September 2020 • Operational
Desert Quartzite	Riverside	California	600	2,673	• PV • ROW grant issued July 2020 • Pending construction
Desert Sunlight	Riverside	California	250	1,659	• PV • ROW grant issued September 2011 • Operational
Desert Sunlight	Riverside	California	300	2,050	• PV • ROW grant issued September 2011 • Operational
Dry Lake Solar Energy Center	Clark	Nevada	130	660	• PV • ROW grant issued December 2019 • Pending construction
Elizabeth Solar I	Yuma	Arizona	300	2,254	• PV • ROW grant issued September 2022
Gemini	Clark	Nevada	690	7,063	• PV • ROW grant issued December 2020 • Pending construction
Harry Allen	Clark	Nevada	130	640	• PV • ROW grant issued April 2018 • Operational

[1] Utility-scale is defined as 5 MW or greater.

Plant Name	County	State	Capacity (MW)	Plant area (acres)	Notes
Harry Allen Solar Energy Center	Clark	Nevada	11	85	• PV • ROW grant issued November 2019 • Pending construction
Heliogen SR2	La Paz	Arizona	165	3,347	• PV • ROW grant issued April 2022 • Pending construction
Luning Solar	Mineral	Nevada	50	584	• PV • ROW grant issued July 2015 • Operational
Luning II Solar	Mineral	Nevada	70	400	• PV • ROW grant issued December 2021 • Pending construction
Maverick 4	Riverside	California	100	605	• PV • ROW grant issued September 2020 • Operational
Maverick 6	Riverside	California	100	638	• PV • ROW grant issued May 2021 • Operational
Maverick 7	Riverside	California	132	848	• PV • ROW grant issued May 2021 • Operational
McCoy Solar Unit 1	Riverside	California	250	2,103	• PV • ROW grant issued December 2013 • Operational
Minersville Solar Energy Parcel B	Beaver	Utah	300	2,708	• PV • ROW grant issued March 2022 • Pending construction
Minersville Solar Energy Parcel C	Beaver	Utah	300	1,818	• PV • ROW grant issued March 2022 • Pending construction
Oberon Solar	Riverside	California	500	2,700	• PV + storage • ROW grant issued January 2022 • Pending construction
Palen Solar	Riverside	California	500	3,140	• PV • ROW grant issued March 2019 • Operational
Playa Solar	Clark	Nevada	79	1,062	• PV • ROW grant issued August 2015 • Operational
Playa Solar	Clark	Nevada	100	735	• PV • ROW grant issued August 2016 • Operational
Silver State North	Clark	Nevada	50	619	• PV • ROW grant issued October 2010 • Operational
Silver State South	Clark	Nevada	250	2,862	• PV • ROW grant issued July 2014 • Operational
Soda Mountain Solar	San Bernardino	California	358	1,767	• PV + storage • ROW grant issued March 2016 • Pending construction

Plant Name	County	State	Capacity (MW)	Plant area (acres)	Notes
Sonoran Solar Energy Project	Maricopa	Arizona	260	3,432	• PV + storage • ROW grant issued October 2021 • Pending construction
Stateline	San Bernardino	California	300	1,685	• PV • ROW grant issued March 2014 • Operational
Sweetwater Solar	Sweetwater	Wyoming	80	584	• PV • ROW grant issued July 2018 • Operational
Victory Pass Solar	Riverside	California	200	1,800	• PV + storage • ROW grant issue December 2021 • Pending construction
Yellow Pine	Clark	Nevada	500	2,987	• PV • ROW grant issued January 2021 • Pending construction

The bars that extend to 2035 in Figure I-6 are from two modeled scenarios. The blue bars are from NREL's 2023 Standard Scenarios Mid Case, assuming policies current as of 2022, which includes the Inflation Reduction Act. Under this scenario, 18–49 GW of utility-scale PV are installed in the United States each year from 2023 through 2035 (NREL 2023). The orange bars represent annual average U.S. utility-scale PV deployment from the Decarbonization with Electrification (Decarb+E) scenario in DOE's *Solar Futures Study*. This study models a 95% reduction in U.S. CO_2 emissions (from 2005 levels) by 2035. Under this more aggressive scenario, annual average utility-scale PV deployment of 24–26 GW from 2023 through 2025 rises to an annual average of 56–66 GW from 2026 through 2035 (DOE 2021).

I.3 Battery Energy Storage

I.3.1 Overview of Battery Technologies

I.3.1.1 Battery Components and Operation

Energy can be stored in many ways. Electrochemical batteries store energy in the form of chemical potential. Italian physicist Alessandro Volta is credited with inventing the first electrochemical battery in 1799 (Andujar et al. 2022). This non-rechargeable battery consisted of a stack of copper and zinc disks separated by brine-soaked cloth, which produced electrical current through wires attached to the ends of the stack (Alarco and Talbot 2015). In 1860, French physicist Gaston Planté invented the rechargeable lead-acid battery, which consisted of lead plates separated by rubber sheets within a solution of sulfuric acid (Aabakken 2006). Lead-acid technology was subsequently improved, and it remains an important part of the battery market (Aabakken 2006, Andujar et al. 2022). Variations of this technology have also been developed, including nickel-cadmium and lithium-ion batteries. All these conventional battery technologies feature a redox reaction between electrodes that results in a current of electrons through an external circuit as well as a flow of cations and anions through an electrolyte (Andujar et al. 2022). In addition, different categories of battery

technology have been developed, including molten salt, redox flow, and metal air batteries (Andujar et al. 2022). Lithium-ion technology dominates today's market for utility-scale battery storage, and some analysts project that 99% of grid-storage batteries through 2029 will use this technology (Mann et al. 2022).

Figure I-7 shows major components within a rechargeable battery and how the battery works, using lithium-ion technology as an example (DOE 2023). When the battery is charging, negatively charged electrons move through an external circuit from the cathode to the anode. At the same time, positively charged lithium ions move through the battery's electrolyte from the cathode to the anode, which balances the charge of the electrons and increases the battery's chemical potential. The battery can then be disconnected from the circuit to store the energy as chemical potential. When a circuit is reconnected and the battery is discharging, the chemical potential is converted into electricity as electrons (through the circuit) and lithium ions (through the electrolyte) move from the anode to the cathode. The battery can be charged and discharged this way repeatedly. However, these processes can degrade the battery's performance over time by changing the structure and chemistry of various materials. Mitigating this degradation is one area of battery research.

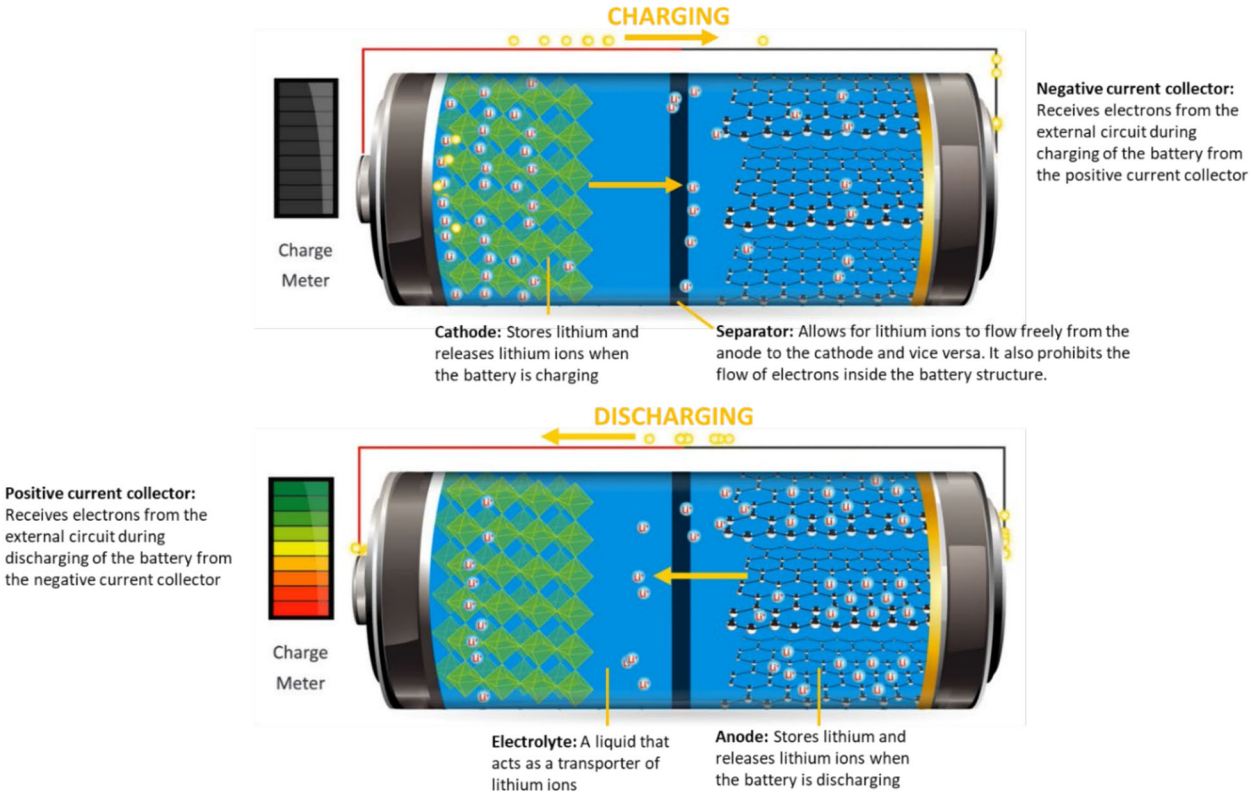

Figure I-7. Schematic of Lithium-ion Battery Operation (DOE 2023)

I.3.1.2 Battery Fabrication

Like PV cell fabrication, battery fabrication involves numerous steps, which would not occur at the sites of the electricity-generating assets being considered for this Solar

Programmatic EIS. Background information is given here to assist in understanding the design and performance of battery storage facilities.

Figure I-8 presents a simplified view of the supply chain for most types of lithium-ion batteries, encompassing the major active cathode and anode materials and the major components of separators and electrolytes. Some additional items required for battery fabrication (e.g., copper foil for anodes, binders, additives) are excluded from the diagram.

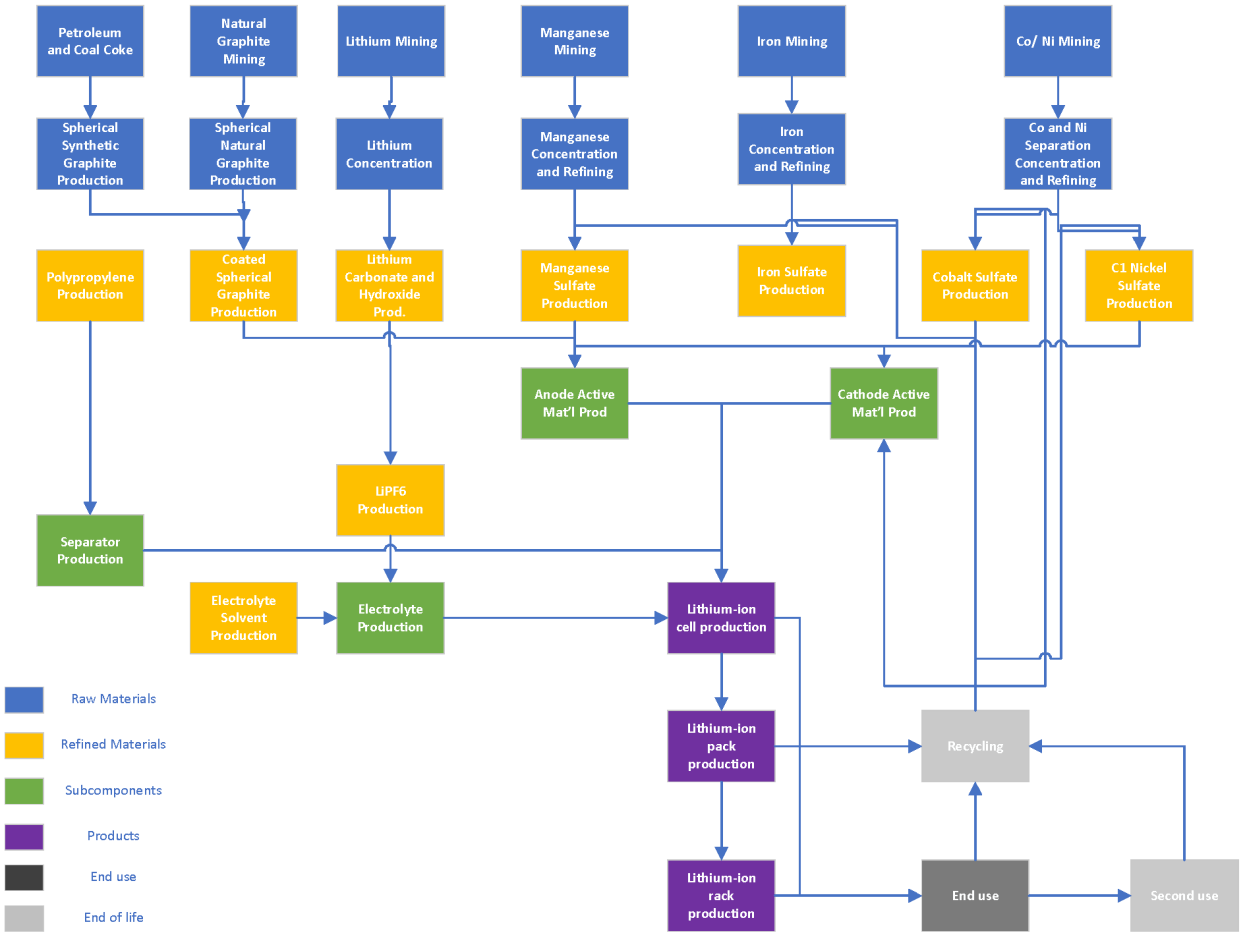

Figure I-8. Lithium-ion battery supply chain diagram (Mann et al. 2022)

Battery cells are the fundamental manufactured products within a battery system. The cells perform the electrochemical conversions illustrated in Figure I-7. Traditionally, cells are connected in series or parallel to form modules, which also contain monitoring and protective equipment. Modules are strung together and combined with additional communication and protective equipment to form packs. Packs are placed within racks along with thermal management systems and electrical and fire protective equipment. In typical utility-scale installations, racks are enclosed in containers that house additional thermal management, battery management, and fire safety systems. Figure I-9 shows these battery system components. For additional details about cell manufacturing processes, see Liu et al. (2021).

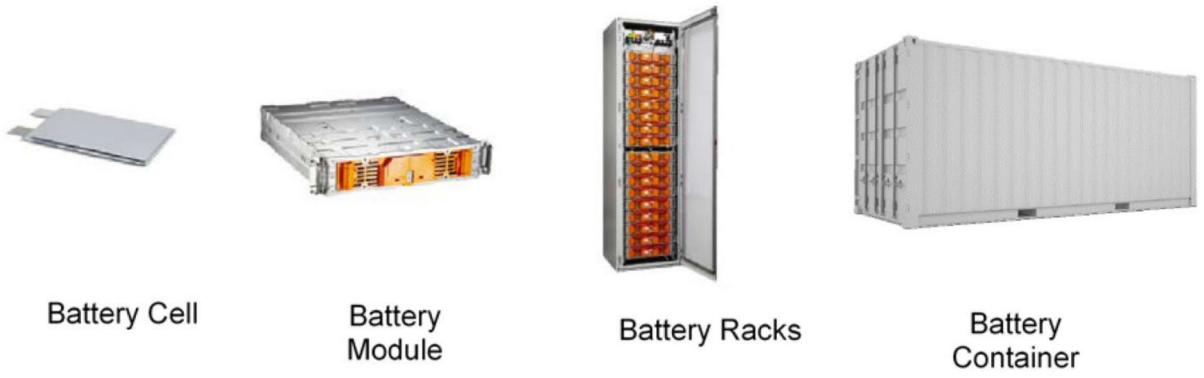

Figure I-9. Battery System Components (Fu et al. 2018)

I.3.1.3 Battery System Design Considerations

The first rechargeable lithium battery was demonstrated in 1974, and the first practical prototype lithium-ion battery was reported in 1985 (Nature Energy 2019). Compared with their predecessors—nickel-cadmium and lead-acid batteries—lithium-ion batteries have a longer lifetime, higher specific energy (energy stored per kilogram of battery), higher specific power (power produced per kilogram of battery), higher roundtrip efficiency, and wider power range (Andujar et al. 2022). For this reason, lithium-ion batteries have become the technology of choice for various applications, including consumer electronics, electric vehicles, and grid storage (Mann et al. 2022).

However, lithium-ion batteries also come with drawbacks. Lithium is expensive compared to some other battery materials, such as sodium (Andujar et al. 2022). From the U.S. perspective, lithium-ion batteries also present supply chain risks. Most materials used in these batteries are concentrated in a few countries outside the United States, and the United States has very limited capacity for material refining, manufacturing of intermediate components, and recycling (Mann et al. 2022). The use of lithium-ion batteries for grid storage presents additional challenges. Grid storage has more diverse operating conditions and performance requirements compared to vehicle storage; lithium-ion batteries are best suited to short-duration (less than 10-hour) storage; lithium-ion technology may present safety issues for stationary applications; and stationary applications must compete with skyrocketing demand for lithium-ion batteries from the vehicle sector (Huang and Li 2022, Trahey et al. 2020, Tuttman and Litzelman 2020, Wood Mackenzie 2022).

Table I-4 lists alternatives to lithium-ion batteries for grid storage, which are at or likely near the commercial stage. Earlier-stage technologies not listed in the table include gravity storage, pumped storage of high-density fluids, liquid air energy storage, biomethane, and storage based on chemicals such as ammonia and hydrocarbons (Mann et al. 2022).

Table I-4. Alternatives to Lithium-ion Batteries for Grid Storage (Mann et al. 2022)

Technology	Notes
Short-duration (< 10 hour) energy storage	
Lead-acid batteries	World's most widely used rechargeable battery technology. Low specific energy. Use for grid storage projected to disappear.
Flow batteries	Low specific energy but decoupled energy and power facilitate scaling. Projected to gain grid market share within the decade.
Thermal energy storage	Uses abundant and inexpensive materials to store heat or cold for later thermal or electrical uses. Still nascent for grid storage.
Flywheel energy storage	Stores energy in a rotating mass. Long lifetime, high efficiency, high capital cost. Still nascent for grid storage.
Emerging battery technologies	
Sodium-ion	Analogous to lithium-ion technology but substitutes cheap and ubiquitous sodium for lithium. In early commercialization phase.
Metal-air	Potential advantages include high theoretical energy densities and low fabrication costs.
Rechargeable magnesium	Potential advantages owing to magnesium's abundance and performance. Optimal material combinations being researched.
Rechargeable aqueous zinc	Similar to rechargeable magnesium batteries. Zinc is even more abundant than magnesium. Pilot testing underway.
Long-duration (≥ 10 hour) energy storage	
Pumped storage hydropower	Stores energy in water reservoirs and converts with turbines. Dominant long-duration option today. Constrained by siting issues.
Compressed air energy storage	Stores energy via compressed air in caverns and converts with turbines. Constrained by siting issues.
Hydrogen	Stores hydrogen from electrolysis in caverns or tanks and converts it to electricity via fuel cells or combustion. Must overcome high capital costs and low roundtrip efficiencies.

I.3.2 Battery Technologies and Facilities

I.3.2.1 Battery Systems

Utility-scale battery facilities can be installed by themselves or in conjunction with generating facilities. They may provide similar benefits to the grid in either configuration. However, installing batteries with generating facilities may provide cost savings.

Figure I-10 shows the components used in a traditional standalone utility-scale lithium-ion energy storage system. These include the batteries (from cells to racks summarized in Figure I-9), the storage container that houses the batteries, a power conversion system, and a step-up transformer. Some manufacturers combine the batteries, battery management system, and inverter in a single ac unit to reduce installation costs (Ramasamy et al. 2022).

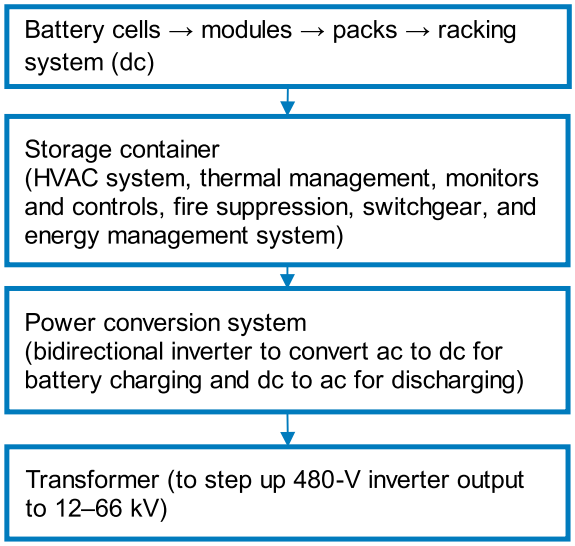

Figure I-10. Traditional Standalone Utility-scale Lithium-ion Energy Storage Components (Ramasamy et al. 2022)

Figure I-11 shows two configurations for installing a utility-scale battery storage system in conjunction with a utility-scale PV system: DC coupling and AC coupling. In the DC-coupled system, the DC output of the PV system charges the battery directly, and a bidirectional inverter enables exports to and imports from the grid. In the AC-coupled system, all DC PV output is converted to AC by a PV inverter, which can then be exported to the grid. To store energy, AC from the PV system or the grid is converted into DC by a bidirectional inverter and sent to the battery pack. To use the stored energy, DC from the battery pack is converted back into AC using the bidirectional inverter and exported to the grid (Ramasamy et al. 2022).

The AC-coupled configuration has several advantages. It may reduce the cost of adding batteries to an existing PV system, because it avoids the rewiring costs associated with a DC-coupled system. The two inverters in an AC-coupled system also provide redundancy and enable independent upgrades of the PV and storage systems. However, DC-coupled systems can also provide benefits. Use of the single bidirectional inverter reduces inverter-related costs. Roundtrip efficiency is higher in DC-coupled systems because there are fewer AC/DC conversions, although increasingly efficient power electronics are shrinking the efficiency difference between AC- and DC-coupled systems. Finally, PV generation beyond the inverter limits can be sent directly to the battery in a DC-coupled system, which increases the output over an AC-coupled system with the same interconnection capacity (Ramasamy et al. 2022).

Ramasamy et al. (2022) benchmark the costs of a 100-MW PV system, a 60-MW/240-MWh battery storage system, and an AC-coupled system combining these PV and battery systems in the first quarter of 2022. They find that the cost of a coupled system is 7% lower than the cost of the two systems sited separately because of lower costs related to hardware (some is shared between the PV and storage systems),

installation labor (due to hardware sharing and reduced labor mobilization), permitting and interconnection (only required once), site preparation (only required once), and profit and overhead (because other costs are lower).

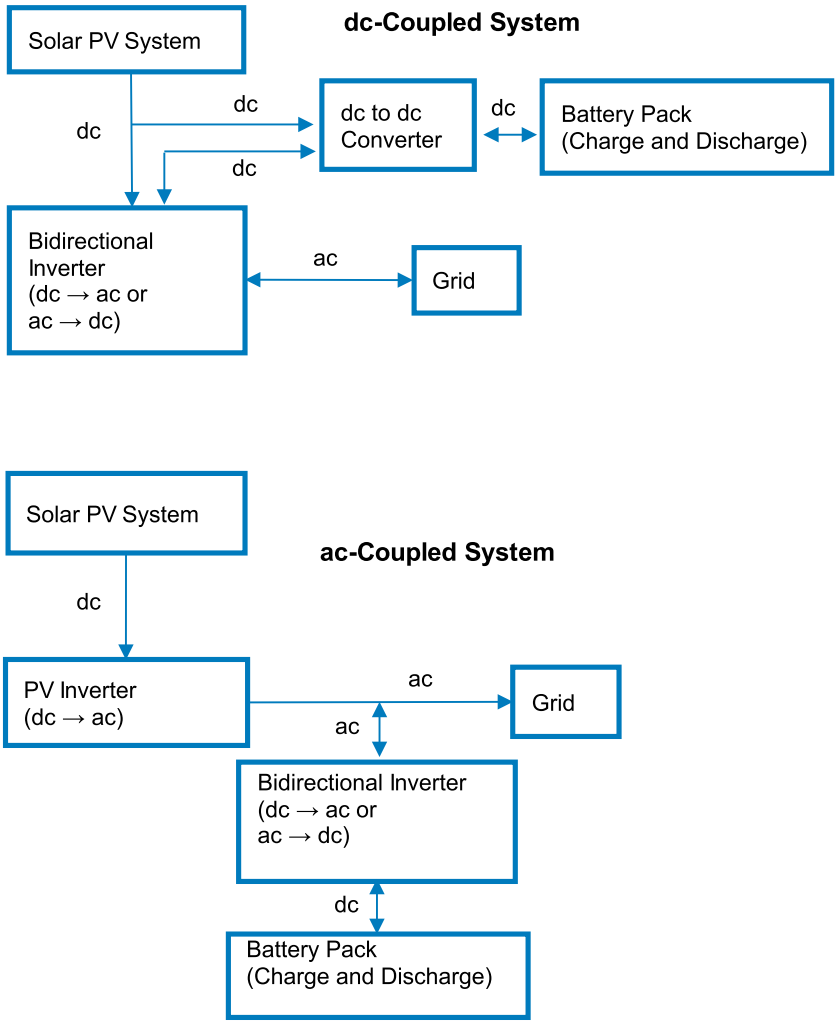

Figure I-11. DC-coupled and AC-coupled PV-plus-storage System Configurations (Ramasamy et al. 2022)

I.3.2.2 Utility-Scale Battery Facilities

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 greenhouse gas emissions and promote the use of renewable energy sources.

Deployment of utility-scale storage—alone and in conjunction with PV and other generators—is expected to surge in the United States as part of the transition toward a decarbonized grid. Figure I-12 shows historical U.S. deployment during 2020–2022, proposed deployment for 2023–2024, and projected deployment through 2035. Annual U.S. battery installations jumped from about 400 MW in 2020 to 2 GW in 2021 and 3 GW in 2022. About a third of the capacity installed during this period is designated as standalone storage, and most of the remaining capacity is designated as part of PV-plus-storage systems. Battery capacity proposed by project developers totals about 9 GW in 2023 and 14 GW in 2024. About 20% of the proposed capacity is listed as part of a PV plant; however, a significant portion of the remainder is likely associated in some way with solar or other proposed or existing electric generation capacity (Feldman et al. 2023). Table I-3 in the previous section includes information about utility-scale PV-plus-storage power plants on BLM-administered lands with a peak capacity of at least 5 MW.

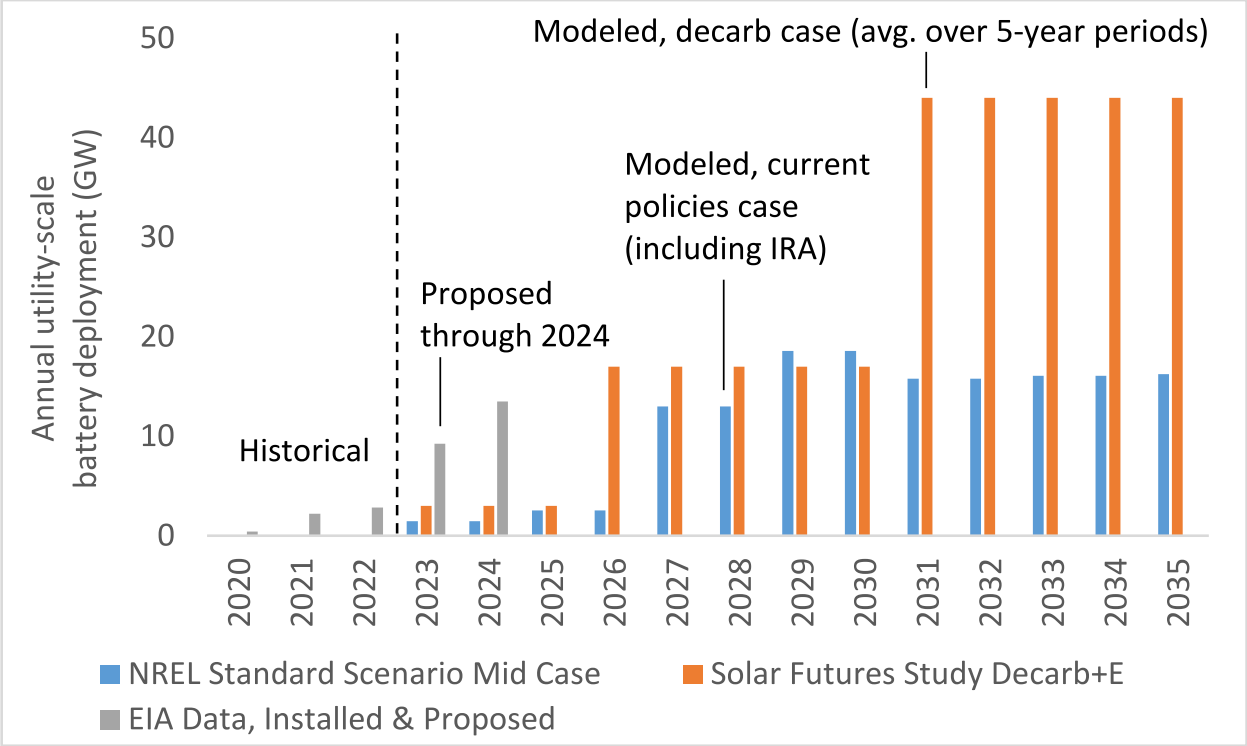

Figure I-12. Annual Utility-scale Battery Deployment in the United States: Historical, Proposed, and Projected

The bars that extend to 2035 in Figure I-12 are from two modeled scenarios. The blue bars are from NREL's 2023 Standard Scenarios Mid Case, assuming policies current as of 2022, which includes the Inflation Reduction Act. Under this scenario, 13-19 GW of batteries are installed in the United States each year from 2027 through 2035 (NREL 2023). The orange bars represent annual average U.S. battery deployment over five-year periods from the Decarbonization with Electrification (Decarb+E) scenario in DOE's *Solar Futures Study*. This study models a 95% reduction in U.S. CO_2 emissions (from 2005 levels) by 2035. Under this more aggressive scenario, annual average battery

deployment of 17 GW from 2026 through 2030 rises to an annual average of 44 GW from 2031 through 2035 (DOE 2021).

I.4 Greenhouse Gas Impacts

Solar PV systems and batteries emit lower levels of greenhouse gases (GHGs) over their life cycles—from resource extraction to manufacturing to operation and eventual recycling and disposal—compared with fossil fuel generators. Figure I-13 provides results from a systematic review of life cycle studies (NREL 2021). The median mass of GHGs emitted per unit of energy is similar across solar PV (including crystalline silicon and thin-film technologies) and other renewable generators, nuclear energy, and electricity storage technologies. However, natural gas, oil, and coal generation without carbon capture and storage (CCS) produce 11 to 23 times more GHGs per unit of energy than solar PV does.

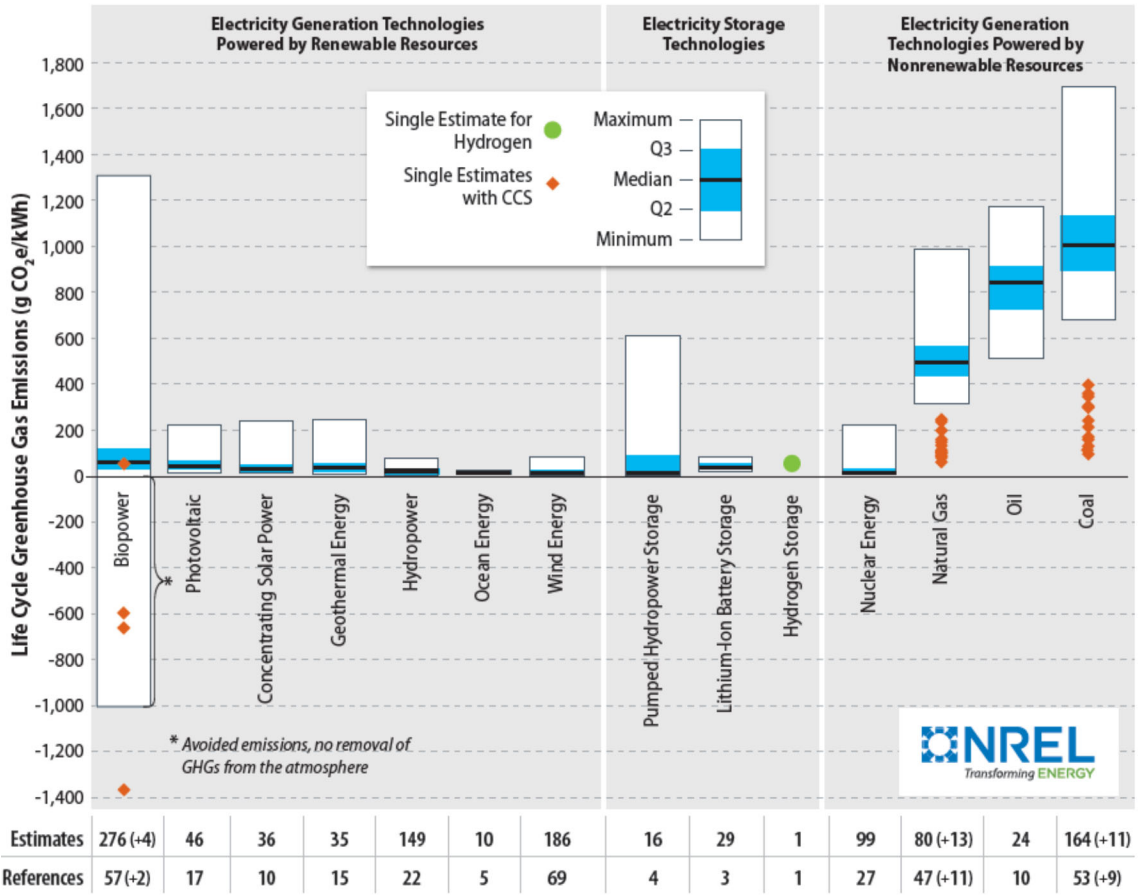

Figure I-13. Life Cycle Greenhouse Gas Emission Estimates for Selected Electricity Generation and Storage Technologies plus Technologies with CCS. Numbers in parentheses indicate additional estimates and references for technologies with CCS (NREL 2021).

The amount of renewable energy produced by a solar PV system is much higher than the amount of nonrenewable energy used to manufacture the system. In fact, the nonrenewable energy "payback time" is about one year for both crystalline silicon and

thin-film technologies (IEA PVPS 2021). In other words, a solar PV system can offset the amount of nonrenewable energy used to manufacture it in about one year, and then generate renewable energy beyond that level for the rest of its expected lifetime of 30 years or more.

I.5 Transmission Lines and Grid Interconnections

This Solar Programmatic EIS addresses the potential impacts of the construction and operation of transmission lines to connect solar energy facilities to the main high-voltage electric transmission grid. This section provides additional information on the major components of high-voltage transmission lines and the potential environmental impacts associated with their construction and operation. The primary factors influencing the design and performance of transmission lines are also briefly discussed. Site-specific impacts of transmission lines (e.g., impacts on specific species and habitats) are not addressed in this section.

Information presented here was taken primarily from a Technical Memorandum published by Argonne National Laboratory (Argonne 2007) and from the Final Programmatic Environmental Impact Statement, Designation of Energy Corridors on Federal Land in the 11 Western States (DOE and DOI 2008b). Those documents, both of which are available electronically at http://corridoreis.anl.gov, provide more in-depth information on these topics.

The North American electric system includes power generation, storage, transmission, and distribution facilities in Canada, United States, and northern Mexico (Baja Norte). The high-voltage transmission grid comprises three main interconnected regions: the Eastern Interconnection, Western Interconnection, and Electric Reliability Council of Texas (ERCOT) Interconnection. The Western Interconnection serves 12 western states (including all eleven states within the scope of this Solar Programmatic EIS), the Canadian provinces of Alberta and British Columbia, and Baja Norte, Mexico.

Within each interconnection, all electric utilities are interconnected and operate synchronously; that is, the generators are operated such that the peak voltage from all generators occurs simultaneously. Voltage from AC generators varies over time following a sine wave, reaching a peak or a minimum of 60 times per second (60 Hz). If all the power contributions from generators were not “in phase,” the voltage from one would cancel some of the voltage from others. Ensuring synchronicity is essential to the transmission grid’s reliability and function. Consequently, each line segment connecting a generating facility to the transmission grid is supported by substations located either at the generator’s facility or at the “point of injection” (or both) that accomplish the necessary power modifications. In addition to ensuring proper phase, transformers are present to adjust voltage to match the grid or to provide for efficient transfer of power to the point of injection. Circuit breakers are present to disconnect the facility should upset conditions occur, and at solar PV facilities inverters are present to convert the direct current produced at the solar panels to alternating current.

I.4.2 Providing for Transmission Grid Reliability and Stability

The Federal Energy Regulatory Commission (FERC) is the primary federal regulatory authority overseeing electric transmission and is responsible for ensuring the reliability of the electricity transmission grid.

NERC's mission is to promote reliability of the bulk electricity transmission systems (i.e., electricity transmitted at 100 kV or greater) that serve North America. To achieve that and in collaboration with all segments of the electric power industry, NERC develops and enforces FERC-approved reliability standards; monitors the bulk power system; assesses future adequacy; audits owners, operators, and users for preparedness; and educates and trains industry personnel. Reliability standards provide for the reliable performance of the North American bulk electric systems without causing undue restrictions or adverse impacts on competitive electricity markets.[2] To ensure consistency in the manner in which individual generating facilities are granted access to the transmission grid and to ensure that such interconnections do not jeopardize the stability of the grid, FERC has also developed a generator interconnection procedure and published a model interconnection agreement, both required to be used for generating facilities with nameplate ratings greater than 20 MW. In June 2022, FERC issued a Notice of Proposed Rulemaking to improve FERC's generator interconnection procedures and agreements. The reforms include reducing lengthy backlogs for projects seeking to connect to the transmission grid, improve certainty in the interconnection process, and ensure that new technologies have access to the transmission grid. FERC issued the final rule (Order No. 2023) on September 6, 2023 (FERC 2023).

In 2006, the North American Electric Reliability Corporation (NERC) was authorized as the Electric Reliability Organization (ERO) for the United States.[3] The ERO Enterprise is comprised of NERC and six Regional Entities that each serve the needs of their regional constituents to assure the effective and efficient reduction of risks to the reliability and security of the bulk power system. The transmission grid segments within the eleven states addressed in this Solar Programmatic EIS are under the control of the Western Electricity Coordinating Council (WECC). WECC is authorized to promulgate regional reliability standards (that must be approved by NERC and FERC) to develop regional reliability criteria or planning standards that complement the NERC reliability and planning standards, or to establish consistent procedures for ensuring compliance with NERC standards among all WECC transmission system participants. Together, the NERC and WECC reliability standards dictate the design and capabilities of transmission system components, the dimensions and conditions of rights-of-way (ROWs), the configurations and capabilities of switchyards and substations, and the monitoring and operating parameters and controls of transmission line segments and interconnections.

[2] All NERC reliability standards can be accessed electronically at https://www.nerc.com/pa/Stand/Reliability%20Standards%20Complete%20Set/RSCompleteSet.pdf.

[3] More information on NERC can be found at the NERC Web site, available at http://www.nerc.com.

I.4.3 Transmission Line Components

As discussed above, reliability standards, together with the characteristics and amount of power expected to be delivered, control every aspect of a solar facility's interconnection to the grid, from the type and size of the electrical devices and controls required at substations, to the design, configuration, and dimensions of line components, to the width of the ROW and the manner in which it is maintained. The more critical components of interconnections are discussed below.

I.4.3.1 Tower Specifications and Construction

The towers support the conductors and provide physical and electrical isolation for energized lines. Voltage; the type, number, weight, and size of conductors (wires) to be supported (typically, three conductors for each circuit present); and the safe separation distances that must be maintained among energized conductors, towers, and ground obstructions to prevent faulting, combine to dictate tower specifications with respect to size, geometry, construction materials, and tower spacing. ROW circumstantial factors such as ground slope, surface and subsurface conditions, wind loading, and weather extremes such as snow and ice can impose additional requirements on the specifications of towers, their spacing, and their foundation requirements. At 500 kV, the material of construction is generally steel, although aluminum and hybrid construction, which uses both steel and aluminum, have also been used. The weight of the tower varies substantially with height, duty (e.g., straight run or change in direction, river crossing), material, number of circuits, and geometry, and can range from 8,500 to 235,000 lb (3,856 to 106,594 kg). The basic function of the tower is to isolate conductors from their surroundings, including controlling the extent of their sag and slope over the expected operating temperature range. Clearances are specified for phase-to-tower, phase-to-ground, and phase-to-phase. For example, phase-to-tower clearance for 500 kV ranges from about 10 to 17 ft (3 to 5 m), with 13 ft (4 m) being the most common specification. These distances are maintained by insulator strings and must take into account possible swaying of the conductors. The typical phase-to-ground clearance is 30 to 40 ft (9 to 12 m). This clearance is maintained by setting the tower height, controlling the line temperature to limit sag, and controlling vegetation and structures in the ROW. Typical phase-to-phase separation is also 30 to 40 ft (9 to 12 m) and is controlled by tower geometry and line motion suppression.[4]

Myriad designs exist for towers, all of which can be placed into one of two general categories: lattice type or monopole. Regardless of their appearance, towers must safely support energized conductors. The voltages at which the conductors are maintained dictate the clearances that must be maintained between each conductor and other conductors, the tower, and ground obstructions. Those clearances dictate

[4] Other factors critical to tower and transmission line performance, such as insulator design, lightning protection, and conductor motion suppression, do not introduce additional environmental impact factors and are not discussed here.

the physical dimensions of the towers and the necessary minimum dimensions of the operating ROW.

Tower erection involves clearing the construction area (typically as much as 80,000 ft^2 [7,432 m^2] and an adjacent tower assembly area (100 by 200 ft [30 by 61 m]) of vegetation. Creating level ground for lifting equipment is required. In general, construction ROW widths can be as much as twice the ROW width needed for safe operation. Excavation, concrete pouring, and pile driving are required to establish foundations, some of which can extend as deep as 40 ft (12 m). Each foundation may require as much as 10 yd^3 (8 m^3) of reinforced concrete. In most instances, ready-mixed concrete is delivered to the site by commercial vendors; however, at particularly remote or rugged sites, special tactics may be employed, such as delivery of the concrete by helicopter or creation of a temporary concrete batch plant near the ROW. Monopole towers utilize a single reinforced-concrete foundation, formed either as a solid cylinder or in the shape of a donut. Lattice-type towers require somewhat less substantial foundations for each of their four legs.

Towers can reach heights of 150 ft (46 m) and widths of 75 ft (23 m). To ensure adequate clearances of conductors to ground interferences, operating ROW widths could approximate twice the width of the tower. Tower spacing on level ground without special concerns for wind or ice loading on power cables would be 1,000 to 1,200 ft (305 to 366 m) for lattice towers and 800 ft (244 m) for monopole towers. Radical changes in grade (e.g., crossing a deep valley or hilly terrain) or anticipated wind and ice can greatly reduce tower spacing or require the installation of exceptionally tall towers to maintain acceptable slope of the conductors between towers or clearances of conductors to ground.

Tower erection also involves the creation of access roads with specifications (grade, turning radius, width, and weight limits) sufficient to handle large, heavy tower components, earthmoving equipment, tower erection equipment, and maintenance equipment. Laydown areas would also be created for temporary storage of tower components (typically 3 acres [0.01 km^2] in size and roughly every 10 mi [16 km] along the ROW). Tower construction can result in the loss of some vegetation, increased potential for wind- and water-induced soil erosion, impacts on surface waters from increased sediment loads, and possible impacts on groundwater from exceptionally deep foundation excavations. Most tower construction-related impacts are of short duration, however, and best management practices have been developed to minimize, if not completely mitigate, most impacts. Additional ROWs established for construction are typically returned to their natural state once construction is complete.

I.4.3.2 Conductor Specification and Installation

Transmitting electrical power over a long distance is not an efficient proposition. Even materials considered excellent conductors of electrical current offer some resistance

to current flow. Resistance is typically manifested as heat.[5] Power losses as high as 10% can result. Various strategies have been pursued to eliminate or at least reduce line loss. Because electrical power (expressed in watts, kilowatts, or megawatts) is the product of voltage times current and since the amount of power lost to heat is proportional to the amount of current being transferred, transmitting electrical power at the highest possible voltage minimizes transmission losses due to heat. Alternatively, a variety of conductor compositions and constructions are currently in use to meet a variety of specific requirements. Although the ideal conductor material is one exhibiting the best electrical conductance properties, the selection of conductor materials typically represents a compromise balancing performance, cost, and weight factors. Because of its weight and cost, copper is typically replaced by aluminum, which offers greater strength-to-weight ratios than copper but only 60% of the electrical conductivity of copper. Aluminum-steel composites are also in widespread use. Most recently, ceramic fibers in a matrix of aluminum have been used, offering high strength even at the elevated temperatures that often result from high current flows during peak power demand periods.

Conductor specifications dictate tower design, specification, and spacing. Regardless of the materials selected, conductor installation is a formidable task, and conductor stringing requires substantial land areas beyond the operating ROW for the staging and operation of installation equipment. A temporary construction ROW would be required to accommodate at least two cable-pulling areas, each about 150 by 250 ft (46 by 76 m). As with tower erection areas and laydown areas, conductor-pulling areas would be returned to their native state after installation is complete.

I.4.3.3 Switchyards and Substations

To minimize power losses over long-distance transfers, existing high-voltage transmission lines in the study area are typically maintained at voltages as high as 500,000 volts (500 kV), substantially greater than the voltage at which power from a solar facility is initially produced. Consequently, the collective purpose of all the equipment in a substation is to condition the power being produced to be compatible with the power present on the grid in both voltage and phase and to provide for immediate isolation of the solar facility from the grid during upset or emergency conditions. For electrical as well as fire safety, substations are typically kept completely free of vegetation, and the area is covered in gravel to promote drainage. Individual pieces of equipment rest on concrete pads or are mounted on metal superstructures. Much of the equipment is filled with as much as hundreds of gallons of dielectric fluids that provide electrical insulation as well as heat dissipation.[6] Although spills or leaks are possible, most equipment is sealed by the manufacturer and remains sealed throughout its operating life. In addition, some designs allow the outer shell of the

[5] Some power is also lost due to corona discharge, the ionization of oxygen molecules in the ambient air surrounding a high-voltage conductor.

[6] Oils containing polychlorinated biphenyls (PCBs) were once common dielectric fluids. However, modern-day equipment is free of PCBs and instead contains synthetic or mineral-based oils. Some equipment contains a gaseous dielectric material, sulfur hexafluoride.

device to provide secondary containment of any leaked fluids. Solar facilities with nameplate ratings of hundreds of megawatts can be expected to have one or more power-conditioning areas, each comprising anywhere from 2 to 10 acres (0.01 to 0.04 km^2).

I.4.3.4 ROWs and Access Roads

A right-of-way, or ROW, is a passive but critical component of a transmission line. It provides a safety margin between the high-voltage lines and surrounding structures and vegetation. The ROW also provides a path for ground-based inspections and access to transmission towers and other line components if maintenance or repairs are needed. Failure to maintain an adequate ROW can result in dangerous situations, including ground faults.

A ROW generally consists of native vegetation or plants selected for favorable growth patterns (slow growth and low mature heights). However, in some cases, access roads constitute a portion of the ROW and provide more convenient access for repair and inspection vehicles.

ROW widths are dictated primarily by the width of the towers being installed, which in most instances is directly proportional to the highest voltage of the circuits present. In some instances, ROW widths are artificially large to allow for avoidance of potentially sensitive or problematic areas along the path. Table I-5 shows the range of minimum ROW width reported by U.S. utilities for various line voltages (for one line of towers). The number of companies reporting each width provides an indication of the most common size ranges.

Access roads will be required; some will be temporary roads constructed only to support certain construction activities, while others will remain throughout the operating life of the transmission line and provide access to the ROW for ground-based inspections and vehicles and equipment needed for maintenance, repairs, or replacements of components. The terrain and overall length of the interconnection line segment may require multiple access roads. Road specifications are dictated by the equipment and vehicles that will use them. In most instances, access roads will enjoy separate ROWs, typically 12 to 14 ft (3.7 to 4.2 m) wide (together with a temporary construction ROW of an additional 3 ft [1 m] along either side of the road). Circumstantial factors will dictate road construction techniques, including special techniques required to cross streams, wetlands, or especially rugged terrain. Roads are likely to be finished in gravel to provide for all-weather access. Access roads that provide primary access to the ROW or to substations may have a more permanent pavement. In most instances, pre-existing roads would be sufficient for the task of transporting equipment, components, and construction vehicles to the ROW. However, in some instances modifications would be required. For example, bridges may need to be strengthened or load height clearances extended, and pathways over water courses may need to be widened and fortified.

Table I-5. Minimum ROW Widths

Voltage (kV)	Range of Widths (ft)[a]	No. of Companies Reporting
<230	<50 51 to 125 >125	51 41 7
230	<75 76 to 125 >125	40 36 30
345	<75 76 to 125 >125	6 36 30
500	<125 126 to 175 >175	4 21 13

[a] For distance in meters, multiply by 0.3048

Source: FERC 2004

I.4.3.5 Additional Structures

For some long-distance transmission line construction projects, additional facilities such as maintenance or repair facilities, material storage areas, administrative buildings, and operational control centers would also be constructed. However, it is not likely that any such facilities would be necessary for the grid interconnection segments being discussed here, and if they are, they would likely be the responsibility of the transmission system operator and not the solar facility operator.[7] It is more likely that at some point along its route, the transmission interconnection segment from a solar facility would share the ROW with a similar segment from another solar facility. Multiple independent transmission lines sharing a ROW create some unique issues associated both with construction and with operation. Designs would be amended to provide adequate spacing between lines to prevent interferences or emergencies on one line from cascading to the second line. Agreements would be required among the parties involved to establish liability limits and assign responsibility for each aspect of ROW maintenance. Coordination of construction- and operation-related activities would also be addressed to prevent adverse impacts on safe operation of either line.

I.4.3.6 Hazardous Materials and Wastes

The hazardous materials used during construction of transmission lines consist primarily of fluids (lubricating oils, hydraulic fluids, glycol-based coolants, and battery

[7] The best solar resources are concentrated in relatively small geographic areas; some of these areas, however, are remote and devoid of existing high-voltage transmission line infrastructure. Nevertheless, for the purpose of this discussion, it is assumed that interconnection transmission line segments would be no more than 25 mi (40 km) in length. This assumption is supported by the existence of state initiatives, such as the Renewable Energy Transmission Initiative (RETI) in California, that seek to facilitate development of renewable energy resources in remote areas by establishing the necessary transmission infrastructure in those areas. Additional details on RETI can be found on the California Energy Commission's Web site at http://www.energy.ca.gov/reti/ documents/index.html. It is further expected that similar initiatives may be pursued in other states within the study area where concentrations of renewable resources exist.

electrolytes) needed to perform primary maintenance on construction vehicles and equipment. Most such materials would be present in portable containers of 55-gal (208-L) capacity or less. Some equipment cannot be easily moved (e.g., exceptionally large lifting cranes that are transported in pieces and assembled onsite, or bulldozers used for initial clearing), which may require the establishment of temporary fueling facilities consisting of portable aboveground tanks holding diesel fuel and/or gasoline.

Compressed gas cylinders of welding and cutting gases such as oxygen and acetylene and modest amounts of cleaning solvents, paints, and corrosion control coatings would also be present. Portable sanitary facilities would also be brought to the construction site. Finally, pesticides used for initial clearing of construction areas, and later in the ongoing maintenance of the ROW, may be present. At associated substations, much of the electrical equipment would be filled with dielectric fluids or gases. However, except in the case of major malfunctions that result in arcing or leaks, these dielectric materials would not be expected to require replacement, and no waste dielectrics typically result from routine operation. At the decommissioning of the transmission line, very large electrical equipment may need to be drained before being relocated, however.

The majority of construction-related wastes are associated with vehicle and equipment maintenance. These wastes are likely to be containerized and briefly stored at the construction area before being removed to offsite treatment or disposal areas. Special arrangements may be necessary for the offsite disposition of very large quantities of vegetation resulting from ROW clearing in some locations. The expected relatively short length of transmission line interconnections suggests that, even in remote areas, there will be no need to establish employer-provided housing for the construction workforce.

Except for pesticides used in ROW maintenance, virtually no hazardous materials would be required during the operating period of the transmission line and related substations, and no operation-related wastes would be generated unless major repairs or replacements are required.

I.4.3.7 Transmission Line Operation and Maintenance

Transmission lines require very little attention and intervention during normal operation. Periodic visual inspections are conducted by driving or walking the ROW or through aircraft flyovers. Inspection frequencies are dictated largely by experience with similar lines operating in similar environments. In rare instances, inspectors may need to climb the towers when close inspections are required to verify the conditions of critical components. ROW vegetation maintenance is conducted in accordance with a preapproved plan. Maintenance may include periodic tree and bush trimming or applications of pesticides, or both. As with inspections, the frequency of ROW maintenance activities is dictated by circumstances and experiences.

Substations and switchyards are also inspected regularly, typically at a higher frequency than the transmission line. Arcing in transformers may require periodic replacement of the dielectric fluids. Replacements of bushings (ceramic insulators that isolate energized wires from the metallic cases of electrical equipment or from the metal

superstructures to which they are attached) may also be necessary. Depending on configuration and function, personnel may need to visit the substation or switchyard to make changes to the routing of power.

During the expected operating lifetime of a transmission line, voltage upgrades, introductions of additional circuits or "double circuits," repairs, or replacements of conductor segments or insulators may all require the reintroduction of heavy equipment of the type used for initial construction. Depending on where such activity occurs, original construction access roads and clearings that were remediated after completion of construction may need to be re-established (together with the necessary amendments to the ROW lease). The impacts of such repairs, upgrades, or refurbishments would be similar to those incurred during initial construction. Likewise, upgrades may also involve replacements of equipment at substations or switchyards.

I.4.3.8 Transmission Line Decommissioning

The expected lifetime of a transmission line is indefinite. It is more likely that the line will undergo upgrades (including replacements of conductors or towers, or both) or the introduction of additional circuits than be abandoned. However, in the event a transmission line segment is abandoned, decommissioning would involve removal of all permanent structures. On the other hand, subsurface foundations may be allowed to remain if their removal would create more disruption than their retention. Virtually all major components, towers, and conductors are likely to remain serviceable and could be reconditioned for similar application on another transmission line segment. Equipment at substations or switchyards is also likely to be appropriate for reinstallation in other parts of the transmission grid or have recycling options. Some large pieces of equipment may need to be drained of their dielectric fluids before removal and transport. Failing that, recycling options would likely exist for all major components. In most areas of the ROW, remediation involves simply allowing native vegetation to re-establish itself. Where all-weather access roads have been removed or where decommissioning activities have resulted in bare soil, fast-growing, noninvasive species may be planted to provide interim erosion control until native vegetation can be re-established.

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Appendix J: Overview of Activities in the 11-State Planning Area

Activities in the 11-state planning area considered in the cumulative impact analysis include projects, actions, and trends that could affect human and environmental receptors within the defined regions of influence and the defined 20-year time frame.

J.1 Energy Production and Distribution

J.1.1 Oil and Gas Production

Oil and gas produced 67% of the total energy supply in the United States in 2022 and almost all of the nation's transportation fuels (EIA 2023a).[1] In 2022, about 21% of domestic oil and in 2021, about 15% of domestic natural gas were produced in the 11-state planning area (EIA 2023b, EIA 2022a). (Note: 2022 data will be available in Sept 2023.)

Table J-1 compares oil production between 2012 and 2022 and gas production between 2012 and 2021 in the planning area. During this period, overall production of oil increased by about 126%. Specifically, oil production increased significantly in Colorado and New Mexico. During this time period, production of oil decreased in Arizona, California, Montana, and Nevada. Overall gas production increased by about 5%, although gas production decreased in California, Montana, Oregon, Utah, and Wyoming. The Energy Information Administration (EIA) projects that domestic petroleum and other liquids consumption through 2040 is not expected to change significantly and for production to remain high as exports of finished products grow in response to international demand (EIA 2023a). Natural gas consumption is expected to remain relatively stable, although production may continue to grow in response to international demand for liquefied natural gas. Given the anticipated stable domestic consumption and continued growth in production, the EIA projects that the United States will remain a net exporter of petroleum products and natural gas through 2050.

In fiscal year (FY) 2022, sales of onshore oil and gas production on federal lands accounted for 11% of all oil and 9% of all natural gas produced domestically (BLM 2023a). In FY 2022, there were 19,366 producible oil and gas leases on Bureau of Land Management (BLM)-administered lands across 10,940,832 acres (Table).

An interagency study of the oil and gas resources on federal lands provides a detailed review of federal oil and gas resources and constraints on their development within 18 geologic provinces across the United States, ten of which are located in the western United States: the Montana Thrust Belt, Powder River Basin, Wyoming Thrust Belt, Denver Basin, Uinta-Piceance Basin, Paradox/San Juan Basin, Southwestern Wyoming Basin, Eastern Oregon-Washington Basin, Eastern Great Basin, and Ventura Basin (DOI 2008). The study found that approximately 33,794,000 acres (136,759 km^2) of the

[1] Oil and gas includes crude oil and lease condensate, natural gas plant liquids, and dry natural gas.

federal land in these basins is available for oil and gas leasing with standard stipulations. Based on resource estimates, these lands contain 1,039 million barrels (117 billion L) of oil and 19.665 trillion ft^3 (0.5569 trillion m^3) of natural gas. Approximately 35,095,000 acres (142,024 km^2) of federal land is available for leasing, with restrictions beyond standard stipulations. Based on resource estimates, these lands contain 3,383 million barrels (438.8 billion L) of oil and 80.126 trillion ft^3 (2.269 trillion m^3) of natural gas. The potential for future expansion in oil and gas exploration, development, and production on federal lands is high. The EIA projects that international demand for liquified natural gas (LNG) exports will result in rising natural gas production in the Southwest, which has easy pipeline transport to the Gulf Coast, where LNG is exported (EIA 2023a).

Table J-1. Trends in Oil and Gas Production in the 11-State Planning Area

State	Oil Production (tbbl)[a]			Gas Production (mcf)[b]		
	2012	2022	Percentage Change	2012	2021	Percentage Change
Arizona	52	6	-88.5	112	229	104.5
California	197,211	122,421	–37.9	234,067	133,136	-75.8
Colorado	49,760	157,532	216.6	1,627,334	1,686,523	3.6
Idaho	0	37	N/A	1,030[c]	1,312	27.4
Montana	26,494	20,576	-22.3	65,463	37,453	-42.8
Nevada	368	229	–37.8	4	4	0
New Mexico	85,551	574,327	571.3	1,131,211	2,041,715	80.5
Oregon	0	0	0	770	320	-58.4
Utah	30,210	46,429	53.7	474,756,	230,767	-51.4
Washington	0	0	0	0	0	0
Wyoming	57,808	90,939	57.3	1,919,726	1,055,521	-45.0
Total	447,154	1,012,496	126.4	5,454,473	5,186,980	4.9

[a] tbbl = thousand barrels. To convert bbl to L, multiply by 159.

[b] mcf = million cubic feet. To convert cf to m^3, multiply by 0.02832.

[c] data is for 2015

Sources: EIA (2023b,c).

Table J-2. Oil and Gas Activities on Public Lands of the United States in FY 2022

State	Producible Leases	Acres[a] in Producing Status
Arizona	0	0
California	312	78,926
Colorado	2,125	1,452,441
Idaho	2	2,333
Montana	1,350	639,113
Nevada	38	29,122
New Mexico	6,780	3,830,186
Oregon	0	0
Utah	1,433	1,037,975
Washington	0	0
Wyoming	7,326	3,870,736
Total	19,366	10,940,832

Source: BLM 2022a.

Oil shale is a sedimentary rock that releases petroleum-like liquid when heated. The mining and processing of oil shale is more complex and expensive than conventional oil recovery; however, increasing oil prices and advances in technology are making it a more feasible energy option. It is estimated that about 72% of the U.S. acreage containing oil shale deposits occurs under federal land in the Green River Formation, a geologic unit that underlies portions of Colorado, Utah, and Wyoming. The oil shale in the Green River Formation has the potential to yield as much as 800 billion barrels (127 trillion L) of oil (BLM 2008). While there are currently no federal oil shale leases for commercial development, six 160-acre research, demonstration, and development (RD&D) leases were issued in 2005 in Colorado and Utah and two additional leases were issued in 2009 in Colorado. The RD&D leases are meant to encourage industry to develop and test technologies aimed at developing oil shale resources on a commercial scale. The BLM prepared a Programmatic environmental impact statement for oil shale leasing in these three states and in 2017 issued a Final Rule to address concerns about the royalty system and to provide more detail regarding environmental protection requirements (BLM 2013a, 2017a). The EIA projects that shale gas and associated dissolved natural gas from oil formations will result in long-term growth of domestic natural gas production through 2050 (EIA 2023a).

Tar sand deposits are another oil-yielding resource under western federal land, primarily in eastern Utah. These deposits are a combination of clay, sand, water, and bitumen that can be mined and processed to produce oil. The in-place tar sands oil resources in Utah are estimated at 12 billion to 19 billion barrels, although there are currently no federal tar sand leases (BLM undated, a). The BLM prepared a Programmatic EIS for tar sands leasing (together with oil shale leasing) in Colorado, Utah, and Wyoming and the Record of Decision (ROD) was signed in 2013 (BLM 2013a).

J.1.2 Coal Production

In 2022, coal accounted for about 22% of the electricity generation in the United States (EIA 2022b). Coal production in the western United States increased 7% in 2021 from the previous year. However, in general, coal production has been decreasing over time. In 2008, 678.5 million short tons (615.5 million MT) of coal were produced in the western states, while less than half (328.5 million short tons) were produced in 2021. Still, over half of the total U.S. coal production (577.4 million short tons) was produced in the western states in 2021 (EIA 2022c). Table J-3 compares coal production between 2011 and 2021 in the six producing states within the 11-state planning area. During this period, overall production decreased in these states by 46%. Coal production is projected to continue to decline in the planning area states as well as nationally. The EIA (2023a) projects a sharp decline in U.S. coal production by 2030 to about 50 percent of current levels with a more gradual decline between 2030 and 2050.

Table J-3. Coal Production in the Producing States Within the 11-State Planning Area in 2002 and 2021[a]

State	2011 (thousand short tons)	2021 (thousand short tons)	Percentage Change from 2011 to 2021
Arizona	8,111	0	
Colorado	26,890	11,875	−55.8
Montana	42,008	28,580	-32.0
New Mexico	21,922	9,265	−57.7
Utah	19,648	12,434	−36.7
Wyoming	438,673	238,773	-45.6
Total	557,252	300,927	−46.0

[a] To convert short tons to metric tons (MT), multiply by 0.9072.

Sources: EIA (2012, 2022c).

J.1.3 Nuclear Electricity Generation

In 2021, nuclear energy generation accounted for almost 19 percent of the total electricity generation in the United States. In the 11-state planning area, nuclear reactors generating electricity are operating in only three states (see http://www.nrc.gov/reactors/operating.html): Arizona, California, and Washington. In Arizona, the Palo Verde Nuclear Generating Station, located approximately 36 mi (58 km) west of Phoenix, has three operating reactors generating approximately 3,870 megawatts of electricity (Mwe). The Palo Verde Nuclear Generating Station was issued a renewed operating license; the current license expires in 2045 (NRC 2022a). California has two operating nuclear reactors at the Diablo Canyon Power Plant, about 12 mi (19 km) west-southwest of San Luis Obispo, with a total generating capacity of 2,240 Mwe. The Diablo Canyon Power Plant has not been issued a renewed operating license; the current license expires in 2024 (NRC 2022b). Also in California, two reactors at the San Onofre Nuclear Generating Station 4 mi (6.4 km) southeast of San Clemente operated with a 2,150 Mwe capacity until it permanently ceased operations in 2013 (NRC 2022c). In Washington, the Columbia Generating Station, located 20 mi north-northeast of Pasco, generates 1,230 Mwe. The Columbia Generating Station was issued a renewed operating license; the current license expires in 2043 (NRC 2022d).

J.1.4 Renewable Energy Development

J.1.4.1 Solar Energy

In 2021, utility-scale solar energy generation accounted for about 14% of renewable electricity generation and about 3% of the total U.S. electricity generation (EIA 2022b). For comparison, in 2011, 1,818 megawatt-hours (MWh) of utility-scale solar energy was generated in the United States and provided only 0.4% of the national energy production (EIA 2022b). Over the 20-year planning period, it is estimated that significant growth in utility-scale solar energy development will occur, including solar energy facilities with battery storage (EIA 2022e). At the end of 2021, there were at least 674 gigawatts (GW) of utility-scale solar power capacity within the interconnection queues nationwide;

284 GW of that capacity (42% of all solar capacity in the queues) include battery storage (Berkeley Lab 2022).

As discussed in Section 1.1.3, as of December 2022 the BLM has permitted 41 solar energy projects, totaling 9,272 MW on approximately 73,000 acres of BLM-administered lands (BLM 2023a). Additionally, as of May 2023 the BLM was processing over 100 applications for utility-scale PV solar energy facilities (BLM 2023f).

J.1.4.2 Wind Energy

In 2021, wind energy accounted for about 47% of the renewable electricity generation and 9.21% of the total U.S. utility-scale electricity generation (EIA 2022b). By comparison, in 2011, 120,177 MWh of wind energy was generated in the United States and provided 3% of the national energy production (EIA 2022b). The BLM manages 20.6 million acres (83,368 km^2) of public lands with wind potential. As of November 2021, the BLM has authorized 35 wind energy projects with a total capacity of more than 2.9 GW on land in western states (BLM undated, b).

J.1.4.3 Geothermal Energy

Geothermal energy resources are the steam and hot water generated by heat from within the earth. In 2021, they accounted for about 2% of utility-scale renewable electricity generation and 0.4% of total U.S. electricity generation (EIA 2022b). Approximately 530 million acres (2.4 million km^2) in 12 western states have geothermal resources with potential for generation of electricity or for heating applications; about 47% of this is on federal lands (BLM and USFS 2008). Currently 48 geothermal power plants are in operation, with a combined total of more than 2.5 GW of generation capacity (BLM undated, c).

J.1.4.4 Hydroelectric Power

In 2021, hydroelectric power generation accounted for about 6% of the total U.S. utility-scale electricity generation (EIA 2022b). California depends heavily on this resource. Since the areas best suited for this technology have already been developed, it is likely that future development of this technology will be relatively low.

The U.S. Army Corps of Engineers (USACE) maintains the National Inventory of Dams (NID), a database of dams in the United States. The NID is a searchable database of about 79,000 U.S. dams. The Web site also provides links to state Web sites with information on dams and hydroelectric projects. It can be accessed at http://crunch.tec.army.mil/.

J.1.4.5 Biomass Resources

In 2021, biomass resources accounted for about 7% of utility-scale renewable electricity generation and about 1% of the total U.S. utility-scale electricity generation (EIA 2022b). It is estimated that restoration activities on as many as 12 million acres (48,562 km^2) of

federal land administered by the BLM would remove biomass that could be used as an energy source.

J.1.5 Transmission and Distribution Systems

In FY 2022, the BLM had a total of 118,399 existing ROWs for oil and gas pipelines and electricity transmission lines in the 11-state planning area (BLM 2023b). This represents a 14.6% increase over the number of ROWs (103,291) in existence in FY 2012. Table J-4 shows the largest increase in ROWs issued between FY 2012 and FY 2022 occurred in Montana (43%), California (23%), and Colorado (23%).

It is expected that demand for additional energy and electricity will increase the number of ROWs across public lands in the years to come. Capacity expansion modeling projects that the national power grid must increase 10% by 2030 and 23% by 2040 to meet a future with moderate load and clean energy growth (DOE 2023a). Other federal agencies authorized to issue ROWs for electric, oil, and gas transmission include the U.S. Forest Service (USFS), the National Park Service (NPS) (electric-only), the U.S. Fish and Wildlife Service (USFWS), the U.S. Bureau of Reclamation (BOR), and the Bureau of Indian Affairs (BIA).

Table J-4. Number of Existing Oil and Gas Pipeline and Transmission Line ROWs on BLM Public Lands in FY 2012 and FY 2022

State	Total ROWs in FY 2012				Percentage Increase from FY 2012 to FY 2022
		MLA[a]	FLPMA[b]	Total	
Arizona	4,753	294	4,821	5,115	7.6
California	7,309	320	8,640	8,960	22.6
Colorado	6,870	1,434	6,982	8,416	22.5
Idaho	5,182	131	6,041	6,172	19.1
Montana	4,147	362	5,549	5,911	42.5
Nevada	8,340	201	8,751	8,952	7.3
New Mexico	31,698	23,762	13,742	37,504	18.3
Oregon	9,964	28	10,898	10,926	9.7
Utah	6,131	1,426	5,431	6,857	11.8
Wyoming	18,897	7,769	11,817	19,586	3.7
Total	103,291	35,727	75,853	118,399	14.6

[a] MLA = Mineral Leasing Act of 1920.

[b] FLPMA = Federal Land Policy and Management Act of 1976.

Sources: BLM (2013b, 2023b).

J.1.5.1 Transmission Line Projects and Related Studies

Numerous energy projects in the western states propose to build inter- and intrastate transmission lines. Some projects emphasize the need to transmit energy from renewable sources; others are intended to improve system reliability and meet the growing demand for electricity in a given region. This section describes planned transmission line projects and related studies in the western United States (including the 11-state planning area). Table J-5 lists planned interstate transmission line projects

that include BLM-administered lands within the 11-state planning area. These projects are considered planned transmission under Alternatives 3 and 5 of this Programmatic EIS, and geospatial data for the preferred alignments designated in corresponding environmental analyses were mapped for those Alternatives.

Table J-5. Planned Transmission Projects on BLM-Administered Lands, Including Expansions, in the 11-State Planning Area

Project Name	Description	Applicant/Sponsor	Phase
Boardman to Hemingway	Approximately 290 mile of primarily 500 kV line between Longhorn Substation in Boardman, Oregon and the Hemingway Substation in Owyhee County, Idaho (approximately 1000 MW power)	PacifiCorp/Idaho Power Co.	Project groundbreaking August 2023
Cross-Tie Transmission Line	214-mile 500-kV line from Utah to Nevada	Trans Canyon	Notice of Intent to Prepare an Environmental Impact Statement was published in April 2022.
Energy Gateway South	500-kilovolt (kV) from Aeolus, Wyoming to Mona, Utah; Sigurd, Utah to Red Butte, Utah	PacificCorp	Sigurd to Red Butte segment was completed in May 2015. Aeolus to Mona segment is under construction.
Energy Gateway West	1,000 mile, 230-kV (150 miles) and 500-kV (850 miles) line from Glenrock, Wyoming to Melba, Idaho	Grid United and Black Forest Partners	Under construction
Greenlink North Project	525-kilovolt (kV), 345-kV, 230-kV, and 120-kV lines from Ely, Nevada to Yerington, Nevada.	NV Energy	Notice of Intent to Prepare an Environmental Impact Statement was published in May 2023.
Greenlink West Project	525-kilovolt (kV), 345-kV, 230-kV, and 120-kV lines between northern and southern Nevada	NV Energy	Draft EIS was published in May 2023.
North Plains Connector	395 mile, up to 500 kV line from Colstrip, Montana to Center and Morton County, North Dakota	Grid United	Planning and Development Phase
Southline	367-mile, double-circuit, 345-kV high voltage transmission line and associated substation from southern New Mexico and southern Arizona.	Hunt Power, LP	Issued a ROD in 2016.
SunZia Southwest Transmission Project	Two 500-kV lines from southern New Mexico to southern Arizona	SunZia Transmission, LLC	Received a ROW grant in 2015, but the applicant submitted a new application to amend their existing BLM ROW grant. The ROD was issued in May 2023.
Ten West Link Transmission Line	125-mile 500-kV line from Tonopah, Arizona and Blythe, California.	Delaney Colorado River Transmission, LLC	ROD issued in 2019. Construction began in 2023.
TransWest Express Transmission Project	±600-kV HVDC from Powder River Basin, Wyoming, through Utah to Las Vegas, Nevada	TransWest Express LLC	Under construction.
Western Bounty Transmission Line	To be provided		

Sources: DOI (2016a,b,c; 2017; 2019; 2022; 2023), BLM (2021, 2022b), WAPA (2016, 2017).

Section 368 Energy Corridors. In 2009, the BLM and USFS designated 6,000 miles of energy corridors on public land as preferred locations for the development of oil, gas, and hydrogen pipelines and electricity and distribution facilities. The decision was subsequently challenged in court and as part of a settlement agreement to resolve the challenge, the BLM, USFS, and Department of Energy (DOE) established a regional review of the energy corridors. The settlement agreement identified 40 Corridors of Concern, which were found to have specific environmental issues such as special status species habitat, proximity to specially designated areas, potential impacts on water or cultural resources, and proximity of and benefit to coal-fired generating stations (U.S. District Court for the Northern District of California 2012). The Section 368 Energy Corridors Regional Review Final Report was published in 2022 and identifies potential revisions, deletions, and additions to the energy corridors, providing recommendations for the BLM and USFS to consider in future land use planning (BLM and USFS 2022).

For analysis of Alternatives 3 and 5 to identify BLM-administered lands proximate to transmission lines, areas within ten miles of the centerlines of Section 368 energy corridors designated to accommodate aboveground development were considered proximate and included as lands available for solar application.[2] Over the 20-year planning period for this effort, it is expected that the BLM will approve new transmission projects within some of the Section 368 energy corridors.

DOE's National Transmission Needs Study. The DOE publishes a National Transmission Needs Study to identify electric transmission capacity constraints or congestion in a geographic area. Areas where a transmission need exists could benefit from an upgraded or new transmission facility to improve reliability and resilience of the power system; alleviate congestion on an annual basis and during real-time operations; alleviate power transfer capacity limits between neighboring regions; deliver cost-effective generation to high-priced demand; or meet projected future generation, electricity demand, or reliability requirements (DOE 2023a) [NOTE - final report expected in Sept 2023 – to be updated].

The following needs were identified for the 11-state planning area based on the geographic regions presented in Figure J-1:

- Improve system reliability and resilience.
    - Extreme heat and wildfires due to climate change have led to localized power outages, which could become more prevalent.
    - In the Northwest, high dependence on variable energy resources to meet peak demand face high risk of load curtailment during extreme conditions.

[2] Section 368 Corridors of Concern as identified in the Settlement Agreement were excluded, that is, not mapped as available for solar ROW applications because some of these areas included potentially sensitive environmental resources. Similarly, Section 368 corridors designated as underground-only were excluded because that designation was mainly for pipeline development.

  - In the Mountain and Southwest regions, transmission upgrades may be necessary in the east to protect system reliability as transmission is expanded along the West Coast.
  - In California, high dependence on solar photovoltaics and imports to meet peak demand face high risk of load curtailment during extreme conditions. In addition, the constrained natural gas system poses a risk to winter reliability when demand for gas is high. Lastly, capacity shortfalls are expected in 2026 due to generation retirements.
  - In the Southwest, there is a need for a more diverse generation portfolio, which can be achieved through additional interregional transmission interconnections.
- Alleviate unscheduled flows between regions in all regions except for the Southwest.
- Increase of transfer capacity between regions to meet projected load and generation growth as well as reliability and resource adequacy needs in the Southwest.
- Increase in transmission deployment to meet projected generation and demand growth for the Mountain and Southwest regions.
- In California, relieve high-priced areas by improving access to low-cost generation.

Figure J-1. DOE National Transmission Needs Study Geographic Regions (Source: DOE 2023)

National Interest Electric Transmission Corridors. Section 216 of the Federal Powers Act (FPA) authorizes the DOE to designate any geographic area as a National Interest Electric Transmission Corridor (NIETC) if they find that current or anticipated future electric energy transmission capacity constraints or congestion adversely affect consumers. On May 13, 2023, DOE published a Notice of Intent and Request for

Information (RFI) in the Federal Register to establish a process to designate" route-specific" NIETCs (DOE 2023b). The intent of the RFI is to solicit comments on program elements that should be included in the guidelines, procedures, and evaluation criteria for the applicant-driven, route-specific NIETC designation process. The NIETC process is based on the DOE's National Transmission Needs Study and would include the consideration of existing ROWs and Section 368 energy corridors.

J.1.5.2 Natural Gas Pipeline Projects

The U.S. natural gas pipeline network is a highly integrated, 3-million-mile network that moves natural gas throughout the continental United States. In 2021, about 27.6 trillion cubic feet of natural gas was delivered to about 77.7 million consumers. Most of the pipeline network is concentrated in the eastern half of the United States (Figure J-2). For example, in 2023 there were 108 planned natural gas pipeline projects across the United States; however, only ten are located within the 11-state planning area (Table J-6) (EIA 2023d). Similarly, 1,117 existing natural gas pipeline projects have been constructed since 1996, but only 216 were located within the planning area (EIA 2023d). Table J-7 summarizes the number of individual pipelines in each state. Many projects are interstate pipelines and one project may cross multiple states, creating the national integrated network.

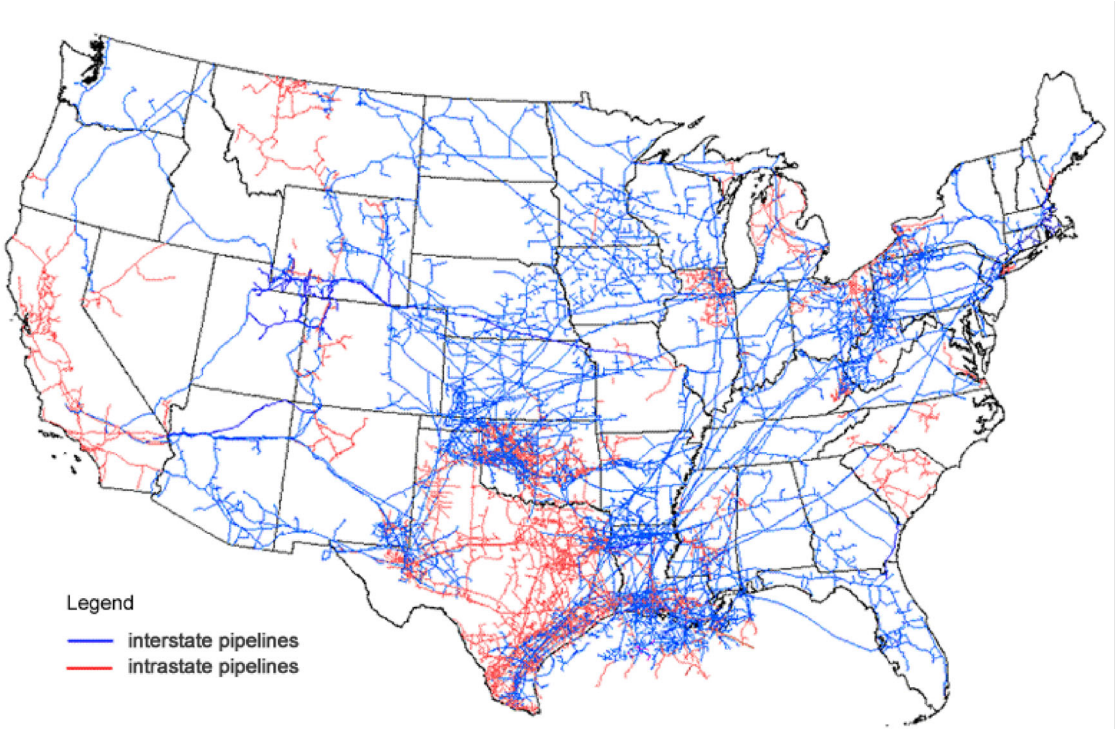

Figure J-2. Map of U.S. Interstate and Intrastate Natural Gas Pipelines
Source: EIA 2022d.

Table J-6. Planned Natural Gas Pipeline Projects in the 11-State Planning Area

Project Name (type)	Locations	Pipeline Operator Name	Status
North Baja Xpress Project (expansion[a])	Arizona, California, MX	TC Energy	Construction
GTN Xpress (expansion)	British Columbia, Idaho, Washington, Oregon	TC Energy	Applied
Line 1600 Replacement Project (expansion)	California	San Diego Gas and Electric, SoCalGas	Approved
Crow Creek Pipeline (new pipeline[b])	Idaho, Wyoming	Lower Valley Energy Coop	Applied
Grasslands South Expansion Project (lateral[c])	North Dakota, Wyoming	WBI Energy Transmission	Applied
Red Hills Lateral Project (lateral)	New Mexico	Double E Pipeline, LLC	Applied
2023 Mainline Replacement Project (upgrade[d])	Nevada	Great Basin Gas Transmission	Applied
Spring Creek Gas Infrastructure Expansion Project (expansion)	Nevada	Southwest Gas Co.	Construction
Pacific Connector (new pipeline)	Oregon	Pacific Connector Pipeline	On Hold
Delta Lateral Project (lateral)	Utah	Kern River Gas Transmission Co	Approved

Source: EIA 2023d

[a] Projects that expanded mainline capacity or mileage including additional compressors, looping, or extensions.

[b] New pipeline system.

[c] Projects that add lateral lines connecting the mainline to power plants, processing plants, industrial plants, storage facilities, and other pipelines.

[d] Projects that replace aging pipeline facilities and increase capacity through system upgrade.

Table J-7. Existing Natural Gas Pipelines (or Portions of Pipelines) Within the 11-State Planning Area(1996–2022)

State	Number of Pipelines
Arizona	23
California	37
Colorado	66
Idaho	2
Montana	8
Nevada	21
New Mexico	27
Oregon	14
Utah	23
Wyoming	60

Source: EIA 2023d.

J.2 Other Activities and Trends

J.2.1 Other Activities

J.2.1.1 Recreation

Recreation visits are tracked for BLM-administered lands and NPS units by state. T-8 lists the number of recreation visits for the BLM and NPS in the 11-state planning area in FY 2012, 2016 and FY 2021. Between 2012 and 2021, visits to BLM-administered lands in the planning area increased by 22.6 million (about 40%), with the greatest increases occurring in Wyoming and Utah.

The latest data for NPS recreation visits is for 2016. From 2012 to 2016, recreation visitation increased by 19.6 million (about 23%). The greatest increases occurred in Oregon and Utah. During that same time period, recreation visits on BLM-administered land increased 11%.

The USFS estimates recreation use on national forests though National Visitor Use Monitoring Surveys and produces National Summary Reports every five years. The 2017–2021 survey results show total visits on USFS land nationwide are estimated to be 156 million, adjusted for the COVID-19 pandemic (USFS 2020).

According to the U.S. Bureau of Economic Analysis, the outdoor recreation economy accounted for 1.9%($454 B) of the national Gross Domestic Product in 2021. The largest outdoor activity was boating/fishing, followed by RVing, hunting/shooting/trapping, and snow activities (BEA 2022).

Table J-8. Recreation Visits for the BLM and NPS in the 11-State Planning Area (FY 2012, 2016 and FY 2022)

State	Visits to BLM-Administered Lands				Visits to NPS Lands[a]		
	FY 2012	FY 2016	FY 2022	Percentage Change	FY 2012	FY 2016	Percentage Change
Arizona	5,595,000	5,016,000	6,318,000	12.9	9,979,972	12,007,544	20.3
California	9,292,000	9,691,000	13,699,000	47.4	35,991,200	41,977,184	16.6
Colorado	7,310,000	7,739,000	10,373,000	41.9	5,811,546	7,457,420	28.3
Idaho	5,931,000	6,058,000	7,192,000	21.3	553,554	629,191	13.7
Montana	4,409,000	4,653,000	5,089,000	15.4	4,451,755	5,655,262	27.0
Nevada	5,989,000	7,642,000	8,920,000	48.9	4,808,929	5,526,764	14.9
New Mexico	2,398,000	3,290,000	3,634,000	51.5	1,502,808	1,872,044	24.6
Oregon	8,008,000	8,849,000	9,893,000	23.5	875,271	1,328,643	51.8
Utah	6,950,000	7,364,000	11,723,000	68.7	9,503,304	14,409,740	51.6
Washington	N/A	N/A	N/A	N/A	7,529,549	8,522,006	13.2
Wyoming	1,400,000	3,250,000	3,083,000	120.2	6,194,752	7,461,666	20.5
Total:	**57,282,000**	**63,552,000**	**79,924,000**	**39.5**	**87,202,640**	**106,847,464**	**22.5**

Sources: BLM 2013b, 2017b, 2023b; NPS 2012, 2016.

J.2.1.2 Minerals Production

Economic production of mineral resources on BLM-administered land includes locatable, leasable, and salable solid minerals. Locatable minerals are subject to the General Mining Law of 1872, as amended, can be obtained by locating a mining claim and include gold, silver, copper, and other hard rock minerals. By the end of FY 2022, there were 482,141 active mining claims in the 11-state planning area on file with the BLM, with the highest number (247,187) in Nevada (BLM 2023b). This represents a 21% increase from FY 2012, in which 397,478 mining claims (199,738 in Nevada) were on file (BLM 2013b). In total, the 2022 mining claims contained more than 11 million acres within the 11-state planning area.

Leasable minerals are subject to the Mineral Leasing Act of 1920 and include energy and nonenergy resources; leases to these resources are obtained through a competitive bidding process. Leasable minerals mined on BLM-administered lands include, but are not limited to, coal, sodium, potassium, phosphate, and gilsonite (a natural, resinous hydrocarbon similar to a hard petroleum asphalt). The number of leases and associated acres for sodium mining has increased since FY 2012, and phosphate, and gilsonite leases have remained relatively steady.

Salable minerals include basic natural resources such as sand and gravel that the BLM sells to the public at fair market value. Other salable materials include soil, stone, clay, and pumice. In FY 2022 in the 11-state planning area, about 10.1 million yd^3 (7.7 million m^3) of mineral materials was disposed of through exclusive and nonexclusive sales and free use permits, representing an increase of about 1.2 million yd^3 (0.92 million m^3) (14%) from FY 2012 (BLM 2013b, 2023b).

J.2.1.3 Military Operations

The U.S. Department of Defense currently owns and manages 265 installations occupying almost 17 million acres (68,800, km^2) in the 11-state planning area, with the greatest acreages in California, New Mexico, and Nevada (DoD 2023). Table categorizes the number and acreages of installations by military service.

Table J-9. Number and Acreage of DoD Facilities by Military Service in the 11-State Planning Area in FY 2021

State	Military Service								Total	
	Army		Navy		Air Force		Marine Corps			
	No.[a]	Acres[b]	No.	Acres	No.	Acres	No.	Acres	No.	Acres
Arizona	5	1,192,596	1	293	9	1,174,076	3	697,557	**18**	**3,064,522**
California	15	280,483	69	1,297,694	26	469,682	13	1,291,135	**108**	**3,657,074**
Colorado	11	400,652	0	0	10	34,682	0	0	**21**	**435,334**
Idaho	5	1,124	1	26	4	128,819	0	0	**10**	**141,713**
Montana	6	22,998	0	0	2	4,765	0	0	**8**	**26,763**
New Mexico	2	3,415,381	9	192,624	0	0	0	0	**11**	**3,608,005**
Nevada	1	147,317	7	254,181	9	2,940,922	0	0	**17**	**3,342,420**

State	Military Service								Total	
	Army		Navy		Air Force		Marine Corps			
	No.[a]	Acres[b]	No.	Acres	No.	Acres	No.	Acres	No.	Acres
Oregon	4	20,548	2	63,745	3	1,170	0	0	**9**	**85,462**
Utah	8	932,932	1	512	5	947,087	0	0	**14**	**1,880,531**
Washington	10	412,134	16	25,594	6	500,526	0	0	**32**	**947,482**
Wyoming	0	0	0	0	2	2,135	0	0	**2**	**2,135**
Total	**67**	**6,826,165**	**106**	**1,834,669**	**76**	**6,203,864**	**16**	**1,988,692**	**265**	**16,853,390**

[a] Numbers represent sites having at least 10 acres and $10M Plant Replacement Value.

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

Source: DoD (2023).

J.2.1.4 Grazing and Rangeland Management

In FY 2012, grazing land accounted for about 63% of the land area in the 11-state planning area. Grazing takes place on lands the Economic Research Service categorizes as cropland, grassland pasture and range, and forest land-grazed (Table). Cropland pasture is the smallest but generally the most productive component of grazing acreage, accounting for only about 8% of the land area in the planning area. Grassland pasture and range occupies about half (51%) of the land area. Grazing is also high on forest land in the planning area, accounting for about 13% of land area. Montana, New Mexico, Arizona, and Nevada have the greatest percentage of grazing land. Almost all BLM-administered lands, as well as the majority of the acreage of the USFS, are available for grazing by private livestock ranchers.

The total grazing land in the United States has declined by about 19% since 1945, mainly because of changes in land use to recreational, wildlife, and environmental uses. Increases in demand for residential, commercial, and industrial development can cause agricultural and forest land to be converted to urban uses (ERS 2017).

Table J-10. Grazing Land in the 11-State Planning Area, 2012[a]

State	Cropland Pasture (1,000 acres[b])	Grassland Pasture and Range (1,000 acres)	Forest Land Grazed (1,000 acres)	Total Grazing Land (1,000 acres)	Percentage of State Land Area
Arizona	1,134	43,580	12,687	57,401	79.0
California	9,577	26,667	13,409	49,653	49.8
Colorado	10,668	31,734	9,972	52,374	79.0
Idaho	5,801	18,391	10,000	34,192	64.6
Montana	16,605	47,629	8,305	72,539	77.9
Nevada	577	52,329	4,394	57,300	81.6
New Mexico	1,948	54,344	11,914	68,206	87.9
Oregon	4,664	23,863	10,060	38,587	62.8
Utah	1,476	32,774	8,187	42,437	80.7
Washington	7,539	7,314	4,368	19,221	45.2
Wyoming	1,986	46,086	6,022	54,094	87.1
Total	**5,147**	**212,883**	**60,260**	**278,290**	**63.2**

[a] Includes both federal and nonfederal land.

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

Source: ERS (2017).

At the end of FY 2022, there were 17,343 permits and leases for livestock grazing, with a total of about 12.2 million active animal unit months (AUMs) on BLM-administered land in the 11-state planning area. Of those, about 8.5 million AUMs (69%) were authorized and in use (BLM 2023b). Table J-11shows the number of grazing permits and leases and AUMs by state for BLM-administered rangeland in FY 2012 and FY 2022. The number of permits and leases in FY 2022 was up about 1% compared to FY 2012. Authorized AUMS were down relative to FY 2012, by about 5%.

Table J-11. Grazing Permits and Leases and AUMs on BLM Public Lands, FY 2012 and FY 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	N/A
Total:	**17,155**	**12,310,245**	**8,924,011**	**17,343**	**12,242,011**	**8,484,172**

[a] An AUM (animal unit month) is the amount of forage needed by an "animal unit" (i.e., a mature 1,000-lb cow and her calf) for one month. Active Animal Unit Months (AUMs): AUMs that could be authorized on public lands. These totals differ from AUM totals shown in the previous tables, which are AUMs authorized for use.

Source: BLM (2013b, 2023b).

Since 1996, there has been a general downward trend in the number of permits and leases and active use of federal lands for grazing. This trend continues a decades-long trend for public land livestock operators and for the livestock industry as a whole as it consolidates into fewer but larger operations. However, permit and leases of federal lands for grazing has remained fairly consistent over the past ten 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 (BLM 2023b).

J.2.1.5 Fire Management

Wildland fires on federal lands are managed by the BLM and other federal agencies. The BLM fire management program is headquartered at the National Interagency Fire Center in Boise, Idaho, and has three levels of organization: the national office (leadership and oversight as well as policy, procedures, and budgets); state offices (coordination of policies and interagency activities at the state level); and district and field offices (on-the-ground fire management and aviation activities). Together these

agencies and offices employ a broad range of activities, including fire suppression, preparedness, predictive measures, fuels management, fire planning, community assistance and protection, prevention and education, and safety. Suppression operations and safety are the core activities for the fire management program (BLM undated, d).

In FY 2022, 20,699 fires affected 5,807,615 acres (23,503 km^2) of forest and nonforest federal lands (of which 881,818 acres [3,569 km^2] were BLM-administered). Of these fires, 74% were attributed to human factors (BLM 2023b). The number of annual wildfires, particularly human-caused wildfires, have been rising. For comparison, in FY 2009, just 2,090 fires affected 430,299 acres (1,741 km^2) of forest and nonforest federal lands (of which 127,497 acres [516 km^2] were BLM-administered). Of the fires in FY 2009, 33% were attributed to human factors (BLM 2010).

Of the total fires in FY 2022, 19,577 occurred within the 11-state planning area, affecting 2,654,491 acres (181,772 acres on BLM-administered land) (BLM 2023b).

J.2.1.6 Forestry

About 34% of the land in the United States is forest land (766 million acres [3.1 million km^2]); of this, about 82 percent (631,682 million acres [2,556 km^2]) is classified as forest-use, a subset of forested land that includes both grazed and ungrazed forests capable of being used for timber harvests. The remainder (134,555 million acres [545 million km^2]) is classified as 'forested land in other uses,' which include parks, wildlife areas, and other special uses, where commercial timber harvests are rare (Bigelow et al. 2017).

Timberland is a class of forest land that is capable of commercial timber production and not removed from timber use by statute or administrative regulation (Bigelow et al. 2017). As of 2017, more than two-thirds of total forested land in the United States was timberland. Within the 11-state planning area, California has the greatest forest land acreage (31.5 million acres [127,500 km^2]), followed by Oregon (29.7 million acres [120,200 km^2]) and Montana (25.5 million acres [103,200 km^2]) (Table J-12). About 58% (122 million acres [494,000 km^2]) of forest land in the planning area is classified as timberland. Timberland makes up the highest percentage of forest land in Washington (80.2%) and Oregon (79.8%) (Oswalt et al., 2019). The U.S. Department of Agriculture (USDA) reports that in recent decades, U.S. forest land and timberland acreage has seen an upward trend, gaining 7 million acres (28,327 km^2) since 2007.

Major timber products include roundwood, lumber (softwood and hardwood), plywood, turpentine, rosin, pulpwood, and paperboard. Total timberland volume exceeds 1 trillion cubic feet. Softwoods comprise the most timber volume in the Rocky Mountains and Pacific Coast regions (including Alaska and Hawaii). Nationwide between 2007 and 2017, softwood growing stock increased in all regions except for the Rocky Mountains, which has been adversely affected by drought and the mountain pine beetle (Oswalt et al. 2019).

J.2.1.7 Transportation

The Federal Lands Highway Program is administered by the Federal Lands Highway Division of the Federal Highway Administration (FHWA) within the U.S. Department of Transportation. The program provides federal financial assistance to construct and improve the National Highway System (NHS), the National Highway Freight Network, urban and rural roads, bridges, tunnels, ferries, bicycle and pedestrian infrastructure, electric vehicle infrastructure, intelligent transportation systems, environmental restoration, and other transportation infrastructure (FHWA 2023). The Federal Lands and Tribal Transportation Program (FLTTP) provides federal funding to improve multimodal transportation facilities that provide access to and within national forests, national parks, other federally owned lands open to the public, and Tribal lands (FHWA 2023). The NPS develops long range transportation plans to enhance visitor experience and ensure positive impacts to surrounding communities and landscapes (NPS 2022).

Table J-12. Land Area, Forest Land, and Timberland in the 11-State Planning Area, 2017

State	Total land area	Total forest land	Total Timberland
Arizona	72,700	10,934	3,012
California	99,699	31,515	16,583
Colorado	66,331	20,063	10,598
Idaho	52,892	21,386	16,532
Montana	93,149	25,517	19,768
Nevada	70,260	7,487	250
New Mexico	77,631	16,619	4,279
Oregon	61,432	29,653	23,668
Utah	52,589	12,087	3,749
Washington	42,532	22,174	17,794
Wyoming	62,140	9,751	5,381
Total	**751,355**	**207,186**	**121,614**

Source: Oswalt et al., 2019

Trucking by far was the most relied-on freight transport mode; trucks transported 12.5 billion tons of freight, about 65 percent of total freight weight and about 8.5 times higher than that of railed freight volume (USDOT 2022). The greatest single commodity by weight is coal and petroleum products, followed by gravel, gasoline, and nonmetallic mineral products. Regional oil shipments by rail increased from less than 1 percent of all regional shipments in 2010 to about 4 percent in 2022. Most of the new oil rail shipments were due to oil production in the Bakken formation.

J.2.1.8 Remediation

The U.S. Environmental Protection Agency uses the National Priorities List (NPL) as an informational tool to identify sites that may present a significant risk to public health and/or the environment. Sites included on the NPL undergo an initial assessment to

determine whether further investigation to characterize the nature and extent of the public health and environmental risks associated with the site is necessary, and to determine what response action, if any, may be warranted. Inclusion of a site on the NPL does not necessarily mean that the EPA will require a response action. The number of sites on the NPL in each of the 11 western states, as of June 2023, is as follows: Arizona, 9; California, 96; Colorado, 20; Idaho, 6; Montana, 18; Nevada, 1; New Mexico, 15; Oregon 14; Utah, 12; Washington, 46; and Wyoming, 1. An additional site in Arizona was proposed in March 2023 in the Federal Register. Additional information on these sites, including site name, description, threats/contaminants, and cleanup status, can be found at https://www.epa.gov/superfund/national-priorities-list-npl-sites-state (EPA 2023).

As of the end of FY 2022, the BLM reported a total of 7,495 sites on its public lands in the 11-state planning area that have had releases of hazardous substances and other pollutants, with the greatest number (1,675 sites, or 22%) having occurred in Nevada. Two other states had release sites numbering more than 10% of the total: California (1,463) and Arizona (1,028). Of the total sites, 4,122 have been closed and administratively archived with no further action planned. During FY 2022, 418 removal actions and 20 remedial actions were conducted on BLM-administered lands in the planning area (BLM 2023b). The number of releases of hazardous substances has increased over the past ten years. In 2012, there were 5,183 hazardous substances releases across the 11-state planning area (BLM 2013b). Historically, 60 percent of all hazardous waste sites on public lands result from commercial uses (including landfills, mines and mill sites, airstrips, and oil and gas sites) and 40 percent were caused by illegal activities. In recent years, however, about 90 percent of hazardous substance releases found on public land have resulted from illegal activities (including dumping of agricultural and industrial wastes, wire burning, and illicit drug production).

J.2.2 General Trends

J.2.2.1 Population Trends

The West is the second fastest growing region in the United States. Between 2012 and 2022, it grew at a faster rate (7%) than the nation as a whole (6%). Seven states within the 11-state planning area had population increases greater than 10% over the 10-year period, with Idaho growing by more than 21% (T). California and Nevada are the most urbanized of the four U.S. regions, with more than 94% of the population living in urban areas in 2022 (Table J-14). In 2022 the percentages of populations living in urban areas in eight of the eleven states in the planning area were above the national average of 80% (U.S. Bureau of the Census 2023a).

The percent of populations living in urban areas decreased in all states within the planning area as well as the United States as a whole. In general, the percentage of those living in urban and rural areas decreased but remained mostly unchanged (less than 1 percent) for seven of the eleven states within the planning area. New Mexico, Wyoming, and Montana experienced the largest decrease in urban area populations (-2.9, -2.7, and -2.5 percent, respectively).

J.2.2.2 Energy Demand

Energy consumption in the United States is projected to increase by 7% between 2022 and 2050 (Table J-15). Fossil fuels, including liquid fuels, natural gas, and coal, would account for about 66% of energy consumption in 2050, down from 80% in 2022. Capital costs for solar panels, wind turbines, and battery storage are expected to decline by 2050 and would result in renewables becoming increasingly cost effective when building new power capacity. As a result of the increase in renewables, the EIA projects a sharp decline in coal consumption and capacity by 2030 (EIA 2023e).

Table J-13. Population Change in the 11-State Planning Area and the United States, 2010–2022

	Population		Percentage Increase 2012– 2022
	2012	2022	
State			
Arizona	6,554,978	7,359,197	12.3
California	37,948,800	39,029,342	2.9
Colorado	5,192,647	5,839,926	12.5
Idaho	1,595,324	1,939,033	21.5
Montana	1,003,783	1,122,867	11.9
Nevada	2,743,996	3,117,772	15.8
New Mexico	2,087,309	2,113,344	1.3
Oregon	3,899,001	4,240,137	8.8
Utah	2,853,375	3,380,800	18.5
Washington	6,897,058	7,785,786	12.9
Wyoming	576,305	581,381	0.9
Region			
West	73,477,823	78,743,364	7.2
Northeast	55,775,216	57,040,406	2.3
Midwest	67,336,743	68,787,595	2.2
South	117,241,208	128,716,192	9.8
Total for United States	**313,830,990**	**333,287,557**	**6.2**

Source: U.S. Bureau of the Census (2023a, 2021).

Table J-14. Rural and Urban Populations in the 11-State Planning Area and the United States, 2010–2020

	2010 (%)		2020 (%)		Urban Increase (%) 2010 to 2020
	Urban	Rural	Urban	Rural	
State					
Arizona	89.8	10.2	89.3	10.7	-0.5
California	95.0	5.1	94.2	5.8	-0.7
Colorado	86.2	13.9	86.0	14.0	-0.1
Idaho	70.6	29.4	69.2	30.8	-1.3
Montana	55.9	44.1	53.4	46.6	-2.5
Nevada	94.2	5.8	94.1	5.9	-0.1

	2010 (%)		2020 (%)		Urban Increase (%) 2010 to 2020
	Urban	Rural	Urban	Rural	
New Mexico	77.4	22.6	74.5	25.5	-2.9
Oregon	81.0	19.0	80.5	19.5	-0.5
Utah	90.6	9.4	89.8	10.2	-0.8
Washington	84.1	16.0	83.4	16.6	-0.7
Wyoming	64.8	35.2	62.0	38.0	-2.7
Total for United States	**80.9**	**19.1**	**80.1**	**19.9**	**-0.8**

Source: BLM (2023b).

Table J-15. Total Energy Consumption, Population, and Carbon Dioxide Emissions for the United States and the Western Region, 2022–2050

Energy-Related Parameter	Year				Percentage Change from 2022 to 2050 (annual rate)
	2022	2030	2040	2050	
United States					
Energy consumption (quadrillion Btu)[a]					
Liquid fuels	36.82	35.46	34.64	36.00	-2.23 (-0.1)
Natural gas	33.18	29.29	29.63	31.13	-6.18 (-0.2)
Coal	9.69	4.40	3.81	3.21	-66.87 (-3.9)
Nuclear electricity	8.06	7.92	6.53	6.53	-18.98 (-0.8)
Renewables[b]	10.24	19.71	24.45	27.8	171.48 (3.6)
Biofuels heat and coproducts	0.92	0.90	0.90	1.00	8.70 (0.3)
Net electricity imports	0.15	0.16	0.16	0.14	-6.67(-0.3)
Total[c]	99.19	97.96	100.25	105.94	6.81 (0.2)
Population (millions)	333.11	346.17	360.76	371.92	28 (0.9)
CO_2 emissions (million metric tons)	4,853.5	4,010.8	3,876.8	3,949.4	8.7 (0.3)
Mountain and Pacific Regions[c]					
Energy Consumption (quadrillion Btu)[a]					
Liquid fuels	7.33	6.88	6.58	6.87	-6.3 (-0.2)
Natural gas	5.50	5.13	5.15	5.50	-0.1 (0.0)
Coal	1.38	0.51	0.27	0.25	-82.2 (-6.0)
Nuclear electricity	0.60	0.43	0.32	0.31	-48.4 (-2.3)
Biofuels heat and coproducts	0.19	0.18	0.17	0.19	-1.3 (-0.1)
Renewables	3.44	5.05	6.14	6.67	93.9 (2.4)
Net electricity imports	0.02	0.03	0.03	0.02	-5.0 (-0.2)
Total[b]	18.46	18.21	18.67	19.81	7.3 (0.3)
Population (millions)	80.64	85.61	91.52	96.96	20.24 (0.7)
CO_2 emissions (million metric tons)	900.18	762.86	719.23	752.31	-16.4 (-0.6)

[a] One million billion, i.e., 10^{15}.

[b] Totals may not equal the sum of components due to independent rounding.

[c] Population and electricity divisions used in projected energy analysis by the EIA include the 11-state planning area as well as Alaska and Hawaii.

Source: EIA (2023f).

Energy consumption is projected to grow at a slightly faster rate (0.3% annually) in the Mountain and Pacific regions than in the nation as a whole (0.2% annually). During the period between 2022 and 2050, the energy consumption in these states is projected to increase by 7%. The highest growth area for energy consumption in the Mountain and Pacific regions is expected to be in renewables. All of the other categories are expected to decrease over the 28-year time period. Coal consumption in the Western states is projected to decrease at an annual rate (6%), a higher rate than that for the United States (4%) (EIA 2023f).

Currently, liquid fuels, natural gas, and renewables account for most of the resources used for electric power generation in the Mountain and Pacific regions. The coal share is projected to decrease to less than 2 percent of the total energy consumption by 2050, while renewable resources would increase from 19% in 2022 to 34% in 2050. However, fossil fuels including liquid fuels, natural gas, and coal are still expected to account for more than half (64%) of energy consumption in the Mountain and Pacific regions in 2050 (EIA 2023f).

J.2.2.3 Water Availability

In 2015 (the latest year for which annual statistics are available at publication), freshwater and saline water withdrawals in the United States were estimated to be 322,000 million gal/day (351,000 thousand ac-ft/yr), with 74% of the total withdrawals coming from surface water. In the 11-state planning area, freshwater and saline water withdrawals were estimated to be 101,600 million gal/day (113,980 thousand ac-ft/year), with the highest usage occurring in California, Idaho, and Colorado. Surface water accounted for 66% of total water withdrawals in the planning area, although about half the water withdrawals in Arizona and New Mexico were from groundwater sources (Table J-16).

The U.S. Geological Survey defines eight categories of water use in the United States: public supply, domestic, irrigation, livestock, aquaculture, industrial, mining, and thermoelectric power. Water withdrawals for these categories for 2005 and 2015 are shown in Table J-17). In the 11-state planning area, the greatest water consumption in the states with highest usage (California, Idaho, and Colorado) is in the category of freshwater for irrigation. Consumption of freshwater via the public supply is generally proportional to the state population. The highest per-capita usage in 2015 occurred in Idaho, Montana, and Wyoming (U.S. Bureau of the Census 2021).

Table J-16. Total Water Withdrawals by Source and State, 2015[a,b,c]

State	Population (thousands)	Water Withdrawals (million gal/day)			Water Withdrawals (thousand ac-ft/yr)
		Groundwater	Surface Water	Total[d]	Total
Arizona	6,830	2,760	3,220	5,980 (46.2)	**6,700**
California	39,100	17,400	11,300	28,800 (60.4)	**32,200**
Colorado	5,460	1,530	8,800	10,300 (14.9)	**11,600**
Idaho	1,650	5,350	12,400	17,700 (30.2)	**19,900**
Montana	1,030	205	9,610	9,810 (2.1)	**11,000**
Nevada	2,890	1,440	1,520	2,960 (48.6)	**3,320**
New Mexico	2,090	1,440	1,460	2,900 (49.6)	**3,250**
Oregon	4,030	1,480	5,100	6,580 (22.5)	**7,370**
Utah	3,000	1,150	3,080	4,230 (27.2)	**4,740**
Washington	7,170	1,530	2,730	4,260 (35.9)	**4,770**
Wyoming	586	748	7,400	8,140 (9.2)	**9,130**
Total	**73,836**	**35,033**	**66,620**	**101,660 (34.5)**	**113,980**

[a] Figures may not add up to totals because of independent rounding.

[b] Totals for groundwater and surface water include both fresh and saline sources.

[c] To convert gal to L, multiply by 3.785. To convert ac-ft to m^3, multiply by 1,234.

[d] Number in parentheses represents percentage groundwater.

Source: Dieter, C.A. et al. (2017).

Table J-17. Total Water Withdrawals by Water-use Category, 2005 and 2015[a]

State	Water Withdrawals (million gal/day)[b]											
	Public Supply Fresh	Domestic Fresh	Irrigation Fresh	Livestock Fresh	Aquaculture Fresh	Industrial		Mining		Thermoelectric Power		Total
						Fresh	Saline	Fresh	Saline	Fresh	Saline	
2005												
Arizona	1,170	27.2	4,810	12.6	11.5	22.4	0	101	2.61	89.9	0	**6,247**
California	6,990	486	24,400	197	646	72.2	23.4	53.1	255	49.6	12,600	**45,772**
Colorado	864	34.4	12,300	33.1	88.0	142	0	6.44	15.0	123	0	**13,606**
Idaho	246	86.6	16,600	44.1	2,490	63.2	0	24.2	0	1.10	0	**19,555**
Montana	142	23.5	9,670	39.0	42.0	67.0	0	35.4	5.12	89.9	0	**10,114**
Nevada	676	37.4	1,500	8.51	15.3	5.90	0	99.1	0	36.8	0	**2,370**
New Mexico	286	32.0	2,810	50.7	20.2	13.2	0	58.7	0	55.9	0	**3,327**
Oregon	530	77.7	5,710	17.8	685	172	0	16.0	0	8.45	0	**7,217**
Utah	607	13.9	4,000	17.8	87.7	35.4	127	5.14	162	58.0	4.18	**5,118**
Washington	990	86.0	3,520	30.7	87.7	454	33.2	26.6	0	456	0	**5,635**
Wyoming	96.3	6.32	3,990	16.2	23.3	6.04	0	51.8	177	223	0	**4,590**
2015												
Arizona	1,200	24.0	4,530	38.9	34.5	6.12	0	68.3	0	83.5	0	**5,985**
California	5,150	127	19,000	183	727	399	0	45.8	272	36.4	2,840	**28,780**
Colorado	844	35.4	9,000	33.3	260	84.1	0	7.70	24.2	37.2	0	**10,326**
Idaho	276	70.2	15,300	50.8	1,960	57.6	0	23.1	0	1.79	0	**17,739**
Montana	153	23.7	9,450	42.2	17.1	9.67	0	21.6	16.3	75.7	0	**9,809**
Nevada	531	35.8	2,070	4.94	34.0	5.71	0	195.0	11.3	8.73	70.9	**2,967**
New Mexico	262	24.6	2,370	32.0	24.1	3.40	0	56.8	89.4	33.5	0	**2,896**
Oregon	567	73.9	5,160	16.3	634	105	0	11.3	0	11.4	0	**6,579**
Utah	627	10.4	3,030	15.9	873.1	54.2	79	3.47	258	61.0	8.46	**4,231**
Washington	867	110	2,520	29.7	245	412	0	17.0	0	52.2	0	**4,253**
Wyoming	101	8.93	7,790	16.2	28.8	8.04	0	44.5	96.8	51.8	0	**8,146**

[a] Figures may not add up to totals because of independent rounding.

[b] To convert gal to L, multiply by 3.785.

[c] Data not collected.

Sources: Dieter, C.A. et al. (2017); Kenny et al. (2009).

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Appendix K: List of Preparers

Table K-1 lists the U.S. Department of the Interior Bureau of Land Management management team members for the Draft Programmatic EIS. Table K-2 lists the names, education, and expertise of the Solar Programmatic EIS preparers.

Table K-1. Bureau of Land Management Team

Name	Office/Title
Leslie Hill	Counselor to the Director, Bureau of Land Management/ Project Manager
Jeremy Bluma	National Renewable Energy Coordination Office, Senior Advisor
Jayme Lopez	National Renewable Energy Coordination Office, Interagency Liaison
Shellie Sullo	National Renewable Energy Coordination Office, Planning and Environmental Analysist
Tracy Perfors	BLM Region 7, Renewable Energy Coordination Office, Planning and Environmental Coordinator; support for geospatial data integrity

Table K-2. Solar Programmatic EIS Preparers

Name	Education/Expertise	Contribution
Argonne National Laboratory		
Timothy Allison	M.S., Mineral and Energy Resource Economics; M.A., Geography; 40 years of experience in regional economic development and economic impact analysis.	Technical lead for socioeconomic analysis
Georgia Anast	B.A., Mathematics/Biology; 30+ years of experience in environmental assessment.	Administrative record manager; glossary
Kevin J. Beckman	B.S., Mathematics and Computer Science; 13 years of experience in Web development, programming, and database design.	Website management; communications database development
Youngsoo Chang	Ph.D., Chemical Engineering; 35 years of experience in air quality and noise impact analysis.	Technical lead for air quality, climate, and noise
Thomas A. Chiodini	M.A. Middle Eastern Archaeology and Language; 5 years of experience in cultural resource management and tribal consultation	Technical lead for paleontology, support for cultural resources and Tribal resources analysis
David Coe	M.S., Atmospheric Science; 7 years of experience in environmental and atmospheric extremes prediction and risk analysis.	Technical lead for wildlands fire
Mike Dwyer	Ph.D., Environmental Science; 45 years of experience in natural resource management.	Technical lead for livestock grazing, recreation, and hazardous materials and waste
Laura Fox	BS Biology; 12 years of experience in environmental and energy assessment.	Project Management support; technical support for stakeholder communications
Mark A. Grippo	Ph.D., Biology; 23 years of experience in aquatic resource studies and impact analysis.	Technical lead for ecological resources (special status species)
Heidi M. Hartmann	M.S., Environmental Toxicology and Epidemiology; 35 years of experience in regulatory environmental impact analysis, and exposure and risk analysis	Project and Program Manager

Name	Education/Expertise	Contribution
Argonne National Laboratory (Cont.)		
John Hayse	Ph.D., Zoology; 32 years of experience in ecological research and environmental assessment.	Technical lead for ecological resources analysis (aquatic)
Chris Howell	Facilitates public and stake holder engagement. Specialized training in Conflict Resolution and Consultation Tools for Cultural and Natural Resources Projects.	Support for cultural resources and Tribal interests
Kathryn Jandeska	M.B.A., BS, Communications; 40 years of experience in communication management, technical writing, and editing.	Editor
Jim Kuiper	M.S. Biometrics and Certificate of Remote Sensing; 36 years of experience in geospatial science.	Technical lead for geospatial information systems (GIS) data analysis and mapping
Sidney Rempel	M.A., Archaeology. 33 years of experience in Old and New World Archaeology including Cultural Resource Management. 22 years of experience in archaeological geomatics and GIS analysis.	Technical lead for cultural resources
Nicole Rice	B.S Anthropology, B.A. American Indian Studies; 9 years of experience working with Tribal communities throughout North America; 5 years of experience in cultural resource management and tribal consultation	Technical lead for Tribal interests
Lorenza Salinas	Document Design and Communications Coordinator; 41 years of experience in creating, revising, formatting, and printing documents.	Document formatting and production
Jordan Secter	M.L.A., Landscape Architecture, BA Community Development, BS Applied Ecology; 24 years of experience in visual resources impact analysis, ecological restoration and recreation resource facility design on public lands.	Supervisory support for visual resources analysis
Carolyn M. Steele	B.A., English; B.A., Rhetoric; 18 years of experience in technical writing and editing.	Lead Editor
Robert Sullivan	M.L.A., Landscape Architecture; 34 years of experience in visual impact analysis and simulation.	Technical lead for visual resources
Katherine Szoldatits	M.S., Biological Sciences; 12 years of experience in environmental assessment and GIS.	Technical lead for ecological resources analysis (wildlife); GIS analysis
William S. Vinikour	M.S., Biology with Environmental Emphasis; 48 years of experience in environmental research and environmental impact assessment.	Technical lead for lands and realty, military and civilian aviation, minerals, specially designated areas, wild horses and burros, and transportation
Leroy J. Walston, Jr.	M.S., Biology; 16 years of experience in ecological research and environmental assessment.	Project management support; supervisory support for all ecological resources assessments
Konstance L. Wescott	M.A., Anthropology; over 35 years of experience in archaeological research and over 30 years of experience in environmental assessment.	Supervisory support for, cultural resources, environmental justice, paleontology, and Tribal interests assessments

Name	Education/Expertise	Contribution
Ellen White	M.P.P, Public Policy; B.A. Environmental Studies; 15 years of experience in environmental and energy assessment.	Project management support; technical lead for technology overview and cumulative impacts assessments
Emily A. Zvolanek	M.S., GIS for Sustainability Management; B.A., Environmental Science; 14 years of experience in GIS analysis and cartography	GIS analysis and mapping
Actalent		
Irene Hogstrom	M.A., Geography and Environmental Studies; B.L.A., Landscape Architecture; over 30 years of experience in landscape architecture, including design, regional planning, and ecological restoration.	Technical lead for ecological resources analysis (vegetation)
Jen Josephs	PhD in Conflict Analysis and Resolution; 7 years of experience in psycho-social, socio-cultural, and socio-environmental research.	Technical lead for Environmental Justice
Pacific Northwest National Laboratory		
Kristen Chojnicki	Ph.D. Geological Sciences; M.S. Geological Sciences; B.S. Earth and Space Science; 8 years of relevant experience in geologic and environmental sciences, including 2 years of experience in resource assessment and environmental impact analysis	Support for geology and soil resources
Dave Goodman	J.D., Law; B.S. Economics. 13 years of experience in NEPA, land use planning, and environmental analyses.	Project Management support; Chapters 1, 2, and Executive Summary; Regulatory summary
Philip Meyer	Ph.D. Civil Engineering, M.S. Civil Engineering, B.A. Physics; 30 years of relevant experience in subsurface hydrology and contaminant transport, including 15 years of experience in soil and groundwater resource assessment and environmental impacts analysis	Technical lead for geology and soil resources
Karen P. Smith	M.S. Geology; 35 years of experience with environmental assessment, impact assessment, stakeholder engagement, and project management	Project management support
Rajiv Prasad	Ph.D. Civil and Environmental Engineering, M.Tech. Hydraulics and Water Resources, B.Tech. Civil Engineering; 23 years of experience in surface water hydrology, process-based modeling, and climate change impacts assessment; 15 years of experience in environmental assessments	Technical lead for water resources analysis
National Renewable Energy Laboratory		
David Feldman	M.B.A; 15+ years of experience in solar energy market research and techno-economic analysis.	Support for technology overview
Jarett Zuboy	M.A., History, B.S., Geology; 20 years of experience in technical writing and analysis related to energy efficiency and renewable energy.	Support for technology overview, battery energy storage

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Appendix L: Glossary

Abiotic: Non-living or non-biological; includes chemical and physical environments and processes.

Access roads: Gravel or dirt roads (rarely paved) that provide overland access to transmission line and pipeline ROWs and facilities for construction, inspection, maintenance, and decommissioning. Access roads have an average distance of 5 mi or less, have a nominal width of 15 ft, and exist within the center of a nominal 25-ft-wide ROW.

Adverse environmental impacts: Impacts that are determined to be harmful to the environment. *See also* Effects.

Affected environment: For an environmental impact statement, a description of the existing environment covering information necessary to assess or understand the impacts. It must contain enough detail to support the impact analyses and must highlight environmentally sensitive resources (e.g., floodplains, wetlands, threatened and endangered species, and archeological resources).

Air quality standards: The legally prescribed level of constituents in the outside air that cannot be exceeded during a specific time in a specified area.

Albedo (effects): The fraction of solar radiation reflected by a surface or object, often expressed as a percentage. Snow-covered surfaces have a high albedo; the albedo of soils ranges from high to low; vegetation-covered surfaces and oceans have a low albedo. The Earth's albedo varies mainly through varying cloudiness, snow, ice, leaf area, and land-cover changes.

All-American Roads: A National Scenic Byway is a road recognized by the U.S. Department of Transportation for its archeological, cultural, historic, natural, recreational, and/or scenic qualities. The most scenic of the roads are called All-American Roads. The designation means they have features that do not exist elsewhere in the United States and are scenic enough to be tourist destinations unto themselves. As of September 2005, there are 99 National Scenic Byways and 27 All-American Roads located in 44 states.

Allotment: An area of land where one or more livestock operators graze their livestock. Allotments generally consist of BLM lands but may also include other federally managed, state owned, and private lands. An allotment may include one or more separate pastures. Livestock numbers and periods of use are specified for each allotment.

Alluvial: Formed by the action of running water; of or related to river and stream deposits.

Alluvium: Deposits of clay, silt, sand, gravel, or other particulate materials that have been deposited by a stream or other body of running water in a streambed, on a flood plain, on a delta, or at the base of a mountain.

Alternating current (AC): An electric current that reverses its direction at regularly recurring intervals.

Alternative: A mix of management prescriptions applied to specific land areas to achieve a set of goals and objectives. Each alternative represents a different way of achieving a set of similar management objectives. Sometimes the term "action alternative" is used when it is desirable to recognize that there is a "no action" alternative under which the proposed activity would not take place.

Ambient Air Quality Standards: Regulations prescribing the levels of airborne pollutants that may not be exceeded during a specified time in a defined area.

Animal unit: A unit of measure for rangeland livestock equivalent to one mature cow or five sheep or five goats, all over 6 months of age. An animal unit is based on average daily forage consumption of 26 pounds of dry matter per day.

Animal Unit Month (AUM): A standardized unit of measurement of the amount of forage required by an animal unit for one month. Also, the measurement of the privilege of grazing one animal for one month.

Appropriate Management Level (AML): The maximum number of animals (wild horses or burros) sustainable on a year-long basis.

Appropriation Doctrine: The system of water law primarily used in the western United States under which 1) the right to water is acquired by diverting water and applying it to a beneficial use; and 2) an existing right to water use is superior to a right developed later in time.

Appropriations: The process of allocating water right allotments and beneficial uses within a water management district.

Aquifer: A water-bearing rock that readily transmits water to a well or spring.

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.

Area sources (emissions): Any source of air pollution that is released over a relatively small area but which cannot be classified as a point source. Such sources may include vehicles and other small engines, small businesses and household activities, or biogenic sources such as a forest that releases hydrocarbons.

Areas of Critical Environmental Concern (ACECs): Areas managed by the Bureau of Land Management and defined by the Federal Land Policy and Management Act of 1976 as having significant historical, cultural, and scenic values, habitat for fish and wildlife, and other public land resources, as identified through the Bureau of Land Management's land-use planning process.

Arrays: *See* Photovoltaic (PV) array.

Artesian groundwater: Groundwater that is under pressure when tapped by a well and is able to rise above the level at which it is first encountered. It may or may not flow out at ground level. The pressure in such an aquifer commonly is called artesian pressure, and the formation containing artesian water is an artesian aquifer or confined aquifer.

Atmospheric absorption: Attenuation of sound during its passage through air, during which its sound energy is gradually converted into heat by a number of molecular processes in the air. The attenuation depends strongly on frequency and relative humidity, less strongly on temperature, and slightly on the ambient pressure.

Attainment: An area considered to have air quality as good as or better than the National Ambient Air Quality Standards for a given pollutant. An area may be in attainment for one pollutant and in nonattainment for others. *See also* In attainment.

Attenuation: The reduction in level of sound.

Battery: Two or more electrochemical cells enclosed in a container and electrically interconnected in an appropriate series and/or parallel arrangement to provide the required operating voltage and current levels. Under common usage, the term *battery* also applies to a single cell if it constitutes the entire electrochemical storage system.

Battery capacity: The maximum total electrical charge, expressed in ampere-hours, that a battery can deliver to a load under a specific set of conditions.

Battery energy storage (BES) system: A battery system that can be charged by electricity generated from renewable energy (like solar and wind) and released when the power is needed.

Beneficial use of water: A use of water resulting in appreciable gain or benefit to the user, consistent with state law, which varies from one state to another. Most states recognize the following uses as beneficial: domestic, municipal, and industrial uses; irrigation; mining; hydroelectric power; navigation; recreation; stock raising; public parks; and wildlife and game preserves.

Benthic: Living in or occurring at the bottom of a body of water.

Best Management Practice (BMP): A practice or combination of practices that are determined to provide the most effective, environmentally sound, and economically feasible means of managing an activity and mitigating its impacts.

Big game: Those species of large mammals normally managed as a sport-hunting resource.

Biological soil crusts: Commonly found in semiarid and arid environments, biological soil crusts are formed by living organisms and their by-products, creating a crust of soil particles bound together by organic materials. Crusts are predominantly composed of cyanobacteria (formerly called blue-green algae), green and brown algae, mosses, lichens, and bryophytes, which live within or on top of the uppermost millimeters of soil. Biological soil crusts are also known as cryptogamic, microbiotic, cryptobiotic, and microphytic crusts.

BLM land: Land administered by the Bureau of Land Management.

Blowout: A wind-eroded section of a sand dune caused by a disturbance or removal of the vegetation.

Boron: The chemical element commonly used as the dopant in a photovoltaic device or cell material.

Borrow pit: A pit or excavation area used for gathering earth materials (borrow) such as sand or gravel.

Broadband noise: Noise that has a continuous spectrum, that is, energy is present over a wide range of frequencies.

Browse: Twigs, leaves, and young shoots of trees and shrubs that animals eat.

Bureau of Land Management: An agency of the U.S. Department of the Interior that is responsible for managing public lands.

Cadastral survey system: A survey that creates, marks, defines, retraces, or re-establishes the boundaries and subdivisions of the public land of the United States.

Cadmium (Cd): A chemical element used in making certain types of solar cells and batteries.

Cadmium telluride (CdTe): A polycrystalline thin-film photovoltaic material.

Candidate Species: Plants and animals for which the U.S Fish and Wildlife Service has sufficient information on their biological status and threats to propose them as endangered or threatened under the Endangered Species Act, but for which development of a listing regulation is precluded by other higher priority listing activities.

Capacity factor: An empirical dimensionless number that represents the ratio of the amount of power produced by a generating facility over a given period of time, to the amount of power that would have been produced over that time period had the facility operated at its rated capacity.

Carrying capacity: The maximum density of wildlife that a particular area or habitat can sustain without deterioration of the habitat.

Cell (solar): *See* Photovoltaic (PV) cell.

Class I Area: As defined in the Clean Air Act, the following areas that were in existence as of August 7, 1977: national parks with more than 6,000 acres, national wilderness areas, national memorial parks with more than 5,000 acres, and international parks.

Clean Water Act (CWA): Requires National Pollutant Discharge Elimination System (NPDES) permits for discharges of effluents to surface waters, permits for storm water discharges related to industrial activity, and notification of oil discharges to navigable waters of the United States.

Clearing and grubbing: Cleaning a site to prepare it for construction. Involves removing debris, structures, shrubbery, trees, obstructions, and objectionable and unsuitable materials. It may also involve handling and disposing of non-hazardous and hazardous waste.

***Code of Federal Regulations* (CFR):** A compilation of the general and permanent rules published in the *Federal Register* by the executive departments and agencies of the United States. It is divided into 50 titles that represent broad areas subject to federal regulation. Each volume of the CFR is updated once every calendar year.

Compact: An agreement between states apportioning the water of a river basin to each of the signatory states.

Compensation: A type of mitigation in which the impacts to a species or habitat are offset by protecting, restoring, or creating suitable habitat elsewhere.

Compensatory mitigation: (For purposes of the Clean Water Act Section 404 and Rivers and Harbors Act Section 10 regulatory programs), the restoration, creation, enhancement or, in exceptional circumstances, preservation of wetlands and/or other aquatic resources for the purpose of compensating for unavoidable adverse impacts that remain after all appropriate and practicable avoidance and minimization has been achieved.

Concentrating solar collector: A device that uses reflective surfaces to concentrate sunlight onto a small area, where it is absorbed and converted to heat or, in the case of solar photovoltaic (PV) devices, into electricity. Concentrators can increase the power flux of sunlight hundreds of times. The principal types of concentrating collectors include compound parabolic, parabolic trough, fixed reflector moving receiver, fixed receiver moving reflector, Fresnel lens, and central receiver (or tower). A PV concentrating module uses optical elements (Fresnel lens) to increase the amount of sunlight incident onto a PV cell. Concentrating PV modules/arrays track the sun and use concentrating devices to reflect direct sunlight onto the solar cell to produce electricity directly.

Concentrating solar power (CSP) technologies: Any of a family of solar energy technologies that reflect and concentrate the sun's energy to produce heat that is subsequently used to produce steam to power a steam turbine-generator (STG), or drive a reciprocating engine, to produce electricity. There are three different types of CSP systems: parabolic trough systems, power tower systems, and solar dish engine systems. Parabolic trough and power tower systems convert sunlight to heat to produce steam, while the solar dish engine system converts sunlight to heat to drive a reciprocating engine. These CSP systems were evaluated in the 2012 Western Solar Plan but their use is no longer prevalent, so they are not evaluated in this Programmatic EIS.

Consumptive use: (1) Any use of water that permanently removes water from the natural stream system. (2) Water that has been evaporated, transpired, incorporated into products, plant tissue, or animal tissue and is not available for immediate reuse. (3) Consumption of water for residential, commercial, institutional, industrial, agricultural, power generation, and recreational purposes. Naturally occurring vegetation and wildlife also consumptively use water. Water consumed is not available for other uses within the system.

Cooperating Agency: Any federal agency (or state, Tribal, or local agency with agreement of the lead agency) other than a lead agency that has jurisdiction by law or special expertise with respect to any environmental impact involved in a proposal (or a reasonable alternative) for legislation or other major federal action that may significantly affect the quality of the human environment.

Corona/corona noise: The electrical breakdown of air into charged particles. The phenomenon appears as a bluish-purple glow on the surface of and adjacent to a conductor when the voltage gradient exceeds a certain critical value, thereby producing light, audible noise (described as crackling or hissing), and ozone.

Corridor: A strip of land through which one or more existing or potential facilities may be located.

Corridor-transmission: *See* Transmission corridor.

Corridor-wildlife: *See* Wildlife corridor.

Council on Environmental Quality (CEQ): Established by National Environmental Policy Act (NEPA), CEQ regulations (40 CFR Parts 1500-1508) describe the process for implementing NEPA, including preparation of environmental assessments and environmental impact statements, and the timing and extent of public participation.

Criteria air pollutants: Six common air pollutants for which National Ambient Air Quality Standards (NAAQS) have been established by the U.S. Environmental Protection Agency under Title I of the Clean Air Act (CAA). They are sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, particulate matter ($PM_{2.5}$ and PM_{10}), and lead. Standards were developed for these pollutants on the basis of scientific knowledge about their health effects.

Critical habitat: The specific area(s) within a geographical area occupied by a species at the time it is listed as endangered or threatened that are essential to the conservation of endangered and threatened species and that may need special management or protection. Critical habitat may also include areas that were not occupied by the species at the time of listing but are essential to its conservation. Critical habitat is not designated for species where such a designation would likely increase the threat of collection, vandalism, or incidental habitat degradation by curiosity seekers.

Crucial winter range: The portion of the winter range to which a wildlife species is confined during periods of heaviest snow cover or that portion of the year-long range that is crucial to survival because it is where big game find food and/or cover during the most inclement and difficult winter weather.

Crustal spreading center: A linear zone in the Earth's crust whose opposite sides are moving away from one another.

Cultural modification: Any human-caused change in the land form, water form, vegetation, or the addition of a structure that creates a visual contrast in the basic elements (e.g., form, line, color, or texture) of the naturalistic character of a landscape.

Cultural resources: Archaeological sites, structures, or features; traditional use areas; and Native American sacred sites or special use areas that provide evidence of the prehistory and history of a community.

Cumulative impacts: The impacts assessed in an environmental impact statement that could potentially result from incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or nonfederal), private industry, or individual undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

Cut-and-fill: The process of earth grading by excavating part of a higher area and using the excavated material for fill to raise the surface of an adjacent lower area.

Day-night average noise level: Twenty-four-hour average noise level, obtained after the addition of a 10-dB penalty for environmental noise occurring from 10 p.m. to 7 a.m. to account for the increased annoyance at night. This 10-dB penalty means that one nighttime noise event is equivalent to 10 daytime noise events of the same level.

Daytime mean rural background level: Daytime (7 a.m. to 10 p.m.) average sound level in the rural environment, from all sources other than a particular noise that is of interest.

Debris flow: A mixture of water-saturated rock debris that flows downslope under the force of gravity (also called *lahar* or *mudflow).*

Decibel (dB): A standard unit for measuring the loudness or intensity of sound. In general, a sound doubles in loudness with every increase of 10 decibels.

Decibel, A-weighted (dBA): A measurement of sound approximating the sensitivity of the human ear and used to characterize the intensity or loudness of a sound.

Decision area: Lands for which the BLM will make land use and management decisions for a particular planning effort.

Decommissioning: All activities necessary to take out of service and dispose of a facility after its useful life.

Depletion: Net loss of water through consumption, export, and other uses to a given area, river system, or basin.

Desert Renewable Energy Conservation Plan (DRECP): A land use plan that identifies areas in the desert appropriate for the utility-scale development of wind, solar, and geothermal projects. It was developed by the California Energy Commission, the California Department of Fish and Wildlife, the U.S. Bureau of Land Management, and the U.S. Fish and Wildlife Service to protect the area and streamline the permitting process. It also specifies requirements for protecting desert wildlife, recreation, cultural and other desert resources.

Desert scrub: A community characterized by plants adapted to a seasonally dry climate.

Design basis: The set of conditions, dimensions, needs, and requirements used to design a solar energy facility.

Design features: Measures or procedures incorporated into the proposed action or alternatives that could avoid or reduce adverse impacts. Potential mitigation measures selected as required are then considered to be design features.

Designated leasing areas (DLAs): Preferred locations for solar energy development.

Direct current (DC): A steady current that flows in one direction only. The current from batteries is an example of direct current.

Direct effects: Effects on the environment that occur at the same time and place as the initial cause or action.

Direct impacts: Impacts occurring at the place of origin and at the time of the proposed activity. An effect that results solely from the construction or operation of a proposed action without intermediate steps or processes. Examples include habitat destruction, soil disturbance, and water use. *See also* Impact.

Direct Normal Insolation (DNI): Sunlight that directly strikes a surface. DNI does not include refracted sunlight that strikes clouds, dust, or the ground first.

Dish engine: A concentrating solar power (CSP) technology that produces electricity, typically in the range of 3 to 25 kilowatts, by using a parabolic array of mirrors to reflect sunlight to heat a working gas (typically hydrogen) in a closed container, causing it to expand and drive a reciprocating engine connected to an electric generator. The dish engine is unique among CSP systems because it uses mechanical energy rather than

steam to produce electricity. Dish engine facilities were evaluated in the 2012 Western Solar Plan but their use is not prevalent, so they are not evaluated in this Programmatic EIS.

Distance zones: A subdivision of the landscape as viewed from an observer position. The BLM-defined zones include foreground, middleground, background, and seldom seen.

Distributed generation: The installation of small-scale solar energy facilities at individual locations that are at or near the point of consumption (e.g., use of solar PV panels on a business or home to generate electricity for onsite consumption). Distributed generation systems typically generate less than 10,000 kW. Other terms for distributed generation include onsite generation, dispersed generation, and distributed energy.

Disturbance (land): *See* Land disturbance.

Dopant: A small amount of a substance added to a material to alter its physical properties, such as conductivity.

Drawdown: Lowering of a reservoir's water level; process of depleting reservoir or groundwater storage.

Dunnage: Package waste. Loose packing material.

Ecoregion: A geographically distinct area of land characterized by a distinctive climate, ecological features, and plant and animal communities.

Edge habitat: The transitional zone where one cover type ends and another begins.

Effects: Environmental consequences (the scientific and analytical basis for comparison of alternatives) as a result of a proposed action. Effects may be either direct, which are caused by the action and occur at the same time and place; or indirect, which are caused by the action and are later in time or farther removed in distance but are still reasonably foreseeable, or cumulative.

Efficiency: Ratio of "power out" divided by "power in." The definitions of power out and power in are specific to a given technology and depend on whether the efficiency value describes a total system efficiency or an individual component's efficiency.

Electric and magnetic field (EMF): That which is generated when charged particles (e.g., electrons) are accelerated. Charged particles in motion produce magnetic fields. Electric and magnetic fields are typically generated by alternating current in electrical conductors. Also referred to as electromagnetic fields.

Electrolytes (battery): A nonmetallic (liquid or solid) conductor that carries current by the movement of ions (instead of electrons) with the liberation of matter at the electrodes of an electrochemical cell.

Eligible historic properties: *See* Historic properties.

Emission factor: Relationship between the amount of pollution produced and the amount of raw material processed.

Emissions: Substances that are discharged into the air from industrial processes, vehicles, and living organisms. A release into the outdoor atmosphere of air contaminants.

Endangered species: Any species (plant or animal) that is in danger of extinction throughout all or a significant part of its range. Requirements for declaring a species endangered are found in the Endangered Species Act of 1973 (ESA). *See also* Special Status Species.

Endangered Species Act of 1973 (ESA): Legislation that requires consultation with the U.S. Fish and Wildlife Service and/or the National Marine Fisheries Service (NMFS) to determine whether endangered or threatened species or their habitats will be impacted by a proposed activity and what, if any, mitigation measures are needed to address the impacts. The purpose of the ESA is to protect and conserve the ecosystems upon which endangered and threatened species depend (Purpose). Section 7(a)(1) is considered as the proactive provision of the ESA, requiring Federal agencies to utilize their authorities in furtherance of the purposes of the ESA by carrying out programs for the conservation of threatened and endangered species. Under section 7(a)(2), Federal agencies must consult with the USFWS/NMFS to ensure that proposed actions neither jeopardize the continued existence of a threatened or endangered species nor cause its critical habitat to be adversely modified or destroyed. Under section 7(a)(2), Federal agencies can include conservation measures (e.g., design features, mitigation) as part of their proposed action.

Entrainment: The incorporation of fish, eggs, larvae, and other plankton with intake water flow entering and passing through a cooling water intake structure and into a cooling water system.

Entry: An application to acquire title to public lands.

Environmental Assessment (EA): A concise public document that a federal agency prepares under the National Environmental Policy Act to provide sufficient evidence and analysis to determine whether a proposed action requires preparation of an Environmental Impact Statement (EIS) or whether a Finding of No Significant Impact can be issued. An EA must include brief discussions on the need for the proposal, the alternatives, the environmental impacts of the proposed action and alternatives, and a list of agencies and persons consulted.

Environmental Impact Statement: A document required of federal agencies by the National Environmental Policy Act for major proposals or legislation that will or could significantly affect the environment.

Environmental justice: The fair treatment of people of all races, cultures, incomes, and educational levels with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

Eolian: The processes of wind erosion, transport, and deposition. For example, sand dunes are landforms produced by eolian processes in arid environments.

Ephemeral stream: A stream that flows only after a storm or during snowmelt and whose channel is, at all times, above the water table; groundwater is not a source of water for the stream. Many desert streams are ephemeral.

Exceedance: A measured level of an air pollutant that is higher than the national or state ambient air quality standards.

Exclusion Criteria (exclusion areas): Areas where solar energy development would be prohibited. Exclusion criteria in the Solar Programmatic EIS include resource exclusions (prohibits solar energy development in sensitive areas) and for Alternatives 2 to 5, a 10% slope exclusion.

Executive Order: A president's or governor's declaration that has the force of law, usually based on existing statutory powers, and requires no action by the Congress or state legislature.

Federal land: Land owned by the United States, without reference to how the land was acquired or which federal agency administers the land, including mineral and coal estates underlying private surface.

Federal Land Policy and Management Act of 1976 (FLPMA): Act requiring the Secretary of the Interior to issue regulations to manage public lands and the property located on those lands for the long term.

***Federal Register*:** The official daily publication for rules, proposed rules, and notices of federal agencies and organizations, as well as executive orders and other presidential documents.

Flat-plate PV: A type of photovoltaic solar energy technology that uses a flat plate onto which are installed solar cells. Sunlight strikes the solar cells directly without being reflected or concentrated. Flat plate systems can be either fixed (stationary) or designed to track the sun's movement over the course of the day.

Fluvial: Pertaining to a river. Fluvial sediments are deposited by rivers.

Flyway: A seasonal route followed by birds migrating to and from their breeding areas.

Fragmentation: Process by which habitats are increasingly subdivided into smaller units, resulting in their increased insularity as well as losses of total habitat area.

Fragmentation of habitat: The breaking up of a single habitat area into two or more smaller habitat patches that are separated from each other.

Fugitive dust: The dust released from any source other than a definable point source such as stack, chimney, or vent. Sources include construction activities, storage piles, roadways, etc.

Gallium (Ga): A chemical element, metallic in nature, used in making certain kinds of solar cells and semiconductor devices.

Geographic information system (GIS): A computer system for performing geographical analysis. GIS has four interactive components: an input subsystem for converting into digital form (digitizing) maps and other spatial data; a storage and retrieval subsystem; an analysis subsystem; and an output subsystem for producing maps, tables, and answers to geographic queries.

Geometric spreading: A phenomenon in which, as sound moves away from its source, the area covered by the sound energy becomes larger and thus sound intensity decreases. Geometric spreading is independent of frequency and plays a major role in sound propagation situations. Due to geometric spreading, the sound level is reduced by 6 dB and 3 dB for each doubling of distance from the point (e.g., fixed equipment) and line (e.g., road traffic) sources, respectively.

Geospatial Data: Information identified with a specific geographical location.

Glare: The sensation produced by luminances within the visual field that are sufficiently greater than the luminance to which the eyes are adapted, which causes annoyance, discomfort, or loss in visual performance and visibility.

Glint: A momentary flash of light resulting from a spatially localized reflection of sunlight.

Global warming: An increase in the near-surface temperature of the Earth. Global warming has occurred in the distant past as the result of natural influences, but today the term is most often used to refer to the warming that many scientists predict will occur as a result of increased anthropogenic emissions of greenhouse gases.

Government-to-government consultation: A formal, two-way dialogue between official representatives of Tribes and federal agencies to discuss federal proposals before the federal agency makes decisions on those proposals.

Grazing allotment: An area where one or more livestock operators graze their livestock. An allotment generally consists of federal land but may include parcels of private or state-owned land.

Grazing lease: An authorization that permits the grazing of livestock on public lands outside the grazing districts during a specified period of time (Section 15 of the Taylor Grazing Act).

Great Basin: An area covering most of Nevada and much of western Utah, as well as portions of southern Oregon and southeastern California, consisting primarily of arid, high elevation, desert valleys, sinks (playas), dry lake beds, and salt flats. The Great Basin is characterized by the fact that all surface waters drain *inward* to terminal lakes or sinks. The Great Basin cultural area extends beyond the physiographic Great Basin to include traditional areas of Tribes who speak languages related to those spoken in the

Great Basin and who traditionally pursued a similar lifestyle. These include the Utes of the Colorado Plateau in eastern Utah and western Colorado.

Greenhouse gases (GHGs): Heat-trapping gases that cause global warming. Natural and human-made greenhouse gases include water vapor, carbon dioxide, methane, nitrogen dioxide, ozone, and chlorofluorocarbons.

Grid: A term used to describe an electrical utility distribution network.

Ground fault mats: Mats made of insulating materials that do not conduct electricity.

Groundwater overdraft: The condition in which water extractions from an aquifer exceed recharge processes in such excess as to cause substantial and sustained decreases in groundwater flows and groundwater elevations.

Groundwater recharge: Inflow of water to a groundwater reservoir from the surface. Infiltration of precipitation and its movement to the water table is one form of natural recharge. Also, the volume of water added by this process.

Grubbing: *See* Clearing and grubbing.

Habitat Connectivity refers to how and to what degree distinct sources of food, water, and shelter for fish, wildlife, and plant populations are distributed and inter-connected, spatially and temporally, across terrestrial and aquatic systems, thereby facilitating or impeding movement among resource patches. Connectivity includes structural connectivity (the physical arrangements of disturbance and/or patches) and functional connectivity (the ability for individuals to move across contours of disturbance or among patches). Without connectivity, ecosystems cannot function properly, and without well-functioning ecosystems, biodiversity is at risk.

Hazardous waste: By-products of society that can pose a substantial or potential hazard to human health or the environment when improperly managed. Possesses at least one of four characteristics (ignitability, corrosivity, reactivity, or toxicity) or appears on special U.S. Environmental Protection Agency lists.

Headwater: (1) The source and upper reaches of a stream; also the upper reaches of a reservoir; (2) the water upstream from a structure or point on a stream; (3) the small streams that come together to form a river; and (4) any and all parts of a river basin other than the mainstream river and main tributaries.

Herd Area (HA): A locale in which wild horses and burros reside. Following passage of the Wild Free-Roaming Horses and Burros Act in 1971, the Bureau of Land Management was directed to identify areas where wild horses and burros were located. Herd areas are not managed for wild horses and burros.

Herd Management Area (HMA): An area that has been designated for management of wild horses and/or burros.

Hertz (Hz): The unit of measurement of frequency, equivalent to one cycle per second.

Historic properties: Any prehistoric or historic districts, sites, buildings, structures, or objects included in, or eligible for inclusion in, the *National Register of Historic Places* maintained by the Secretary of the Interior. They include artifacts, records, and remains that are related to and located within such properties.

Historic resources: Material remains and the landscape alterations that have occurred since the arrival of Euro-Americans.

Impact: The effect, influence, alteration, or imprint caused by an action.

Impingement: The entrapment of aquatic organisms on the outer part of an intake structure or against a screening device during periods of intake water withdrawal.

IMPLAN: Input-output economic model based on economic accounts showing the flow of commodities to industries from producers and institutional consumers. The accounts also show consumption activities by workers, owners of capital, and imports from outside the region.

Impoundment (surface): A body of water or sludge confined by a dam, dike, floodgate, or other barrier.

In attainment: In compliance with air-quality standards. Areas that are in attainment have air quality that is as good as or better than specified in the National Ambient Air Quality Standards for a given pollutant. An area may be in attainment for one pollutant and nonattainment for others.

Indian trust assets: 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.

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 Executive Orders, which are protected by a fiduciary obligation on the part of the United States.

Indirect effects: Secondary effects that occur in locations other than that of the initial action or significantly later in time.

Indirect impacts: Impacts that occur away from the place of origin. Effects that are related to, but removed from, a proposed action by an intermediate step or process. An example would be changes in surface-water quality resulting from soil erosion at construction sites.

Infrastructure: The basic facilities, services, and utilities needed for the functions of an industrial facility or site. Examples of infrastructure for utility-scale solar facilities are access roads, transmission lines, meteorological towers, etc.

Insolation: The solar power density incident on a surface of stated area and orientation, usually expressed as watts per square meter or btu per square foot per hour.

Invasive species: Any species, including noxious and exotic species, that is an aggressive colonizer and can out-compete indigenous species.

Inverter: An electrical device that converts direct current (DC) into alternating current (AC).

Irradiance: *See* Insolation.

Kilowatt: A unit of electrical power equal to 1,000 watts (W).

Land disturbance: Discrete event or process that alters soil and/or kills or damages vegetation. From an ecological and hierarchical perspective, disturbance is a change in the minimal structure of an ecosystem caused by a factor external to the reference structure. Examples of disturbance are habitat reduction, habitat fragmentation, and habitat alteration.

Landscape-level planning: A holistic approach to landscape management that aims to balance the completing objectives of economic development with those that are concerned with protecting cultural and natural resources. Landscape-level refers to an area that contains multiple and interacting land-uses, watersheds, and ecosystems.

Land subsidence: The sinking or settling of land to a lower level in response to various natural and human-caused factors. With respect to groundwater, subsidence most frequently results from overdrafts of the underlying water table or aquifer and its inability to fully recharge, a process called aquifer compaction. *See also* Subsidence.

Land use: A characterization of land surface in terms of its potential utility for various activities.

Land Use Plan: A set of decisions that establish management direction for land within an administrative area, as prescribed under the planning provisions of FLPMA; an assimilation of land-use-plan-level decisions developed through the planning process outlined in 43 CFR 1600, regardless of the scale at which the decisions were developed. *See also* Resource Management Plan.

Land withdrawal: Withdrawals are governed by regulations issued under FLPMA, contained in 43 CFR Part 2300. A withdrawal is defined as: “Withholding an area of federal land from settlement, sale, location, or entry under some or all of the general land laws, for the purpose of limiting activities under those laws in order to maintain other public values in the area or reserving the area for a particular public purpose or program; or transferring jurisdiction over an area of Federal land, other than property governed by the Federal Property and Administrative Services Act (40 U.S.C. 472), from one department, bureau or agency to another department, bureau or agency.” (*See* 43 CFR 2300.0-5(h).)

Landscape character: The arrangement of a particular landscape as formed by the variety and intensity of the landscape features and the four basic elements of form, line, color, and texture. These factors give the area a distinctive quality that distinguishes it from its immediate surroundings.

Law of the River: A complex body of laws, court decrees, contracts, agreements, regulations, and an international treaty used to govern allocation and management of Colorado River water.

Laydown area: An area that has been cleared for the temporary storage of equipment and supplies. To ensure accessibility and safe maneuverability for transport and off-loading of vehicles, laydown areas are usually covered with rock and/or gravel.

L_{dn}: The day-night average sound level. L_{dn} is the average A-weighted sound level over a 24-hour period that gives additional weight to noise that occurs during the night (10:00 p.m. to 7:00 a.m.) to account for the greater sensitivity of most people to nighttime noise.

Leasable minerals: Federal minerals such as coal, oil shale, oil, gas, phosphate, potash, sodium, tar sands, geothermal resources, potassium, asphaltic materials, and all other minerals that are subject to lease under the Mineral Leasing Act of 1920, as amended and supplemented.

L_{eq}: Equivalent/continuous sound level. L_{eq} is the steady sound level that would contain the same total sound energy as the time-varying sound over a given time.

Liquefaction: A sudden loss of strength and stiffness in loose, saturated soils. Liquefaction causes a loss of soil stability and can result in large, permanent displacements of the ground.

Locatable Minerals: Minerals or materials subject to disposal and development through the Mining Law of 1872 (as amended). Generally include metallic minerals such as gold, copper, lead, and silver and other materials that are not subject to lease or sale (i.e., oil and natural gas).

Maintenance area: Any geographic region of the United States previously designated nonattainment pursuant to the CAA Amendments of 1990 and subsequently redesignated to attainment subject to the requirement to develop a maintenance plan under Section 175A of the CAA, as amended.

Median household income: Divides households into two equal segments, with one-half of households earning less than the median household income and the other half earning more. Median income is a better indicator of typical income levels in an area than average household income as median income is not dramatically affected by unusually high or low values.

Megawatt (MW): A unit of power equal to one million watts (equivalent to one joule per second). One megawatt serves about 300 homes in the western United States based on national data.

Megawatt electrical (MWe): One million watts of electrical energy; a measure of electrical power capacity, use in PEIS is synonymous with MW.

Memorandum of Understanding (MOU): An agreement between two or more parties outlined in a formal document. A Memorandum of Understanding is not necessarily legally binding.

Mesic habitat: A habitat type characterized by the presence of a moderate amount of moisture or water. *Opposite:* xeric.

Migratory Bird Treaty Act (MBTA): Legislation that implements various treaties and conventions between the United States and Canada, Japan, Mexico, and the former Soviet Union for the protection of migratory birds. The MBTA made it illegal for people to "take" migratory birds, their eggs, feathers, or nests. *See also* Take.

Military Training Route (MTR): A designated corridor of airspace with defined vertical and lateral dimensions established for conducting military flight training at airspeeds in excess of 250 nautical miles per hour.

Milligauss (mG): A unit of measure for magnetic fields.

Mineral Leasing Act of 1920 (MLA): Legislation that authorizes the issuance of rights-of-way grants for oil and gas gathering and distribution pipelines and related facilities not already authorized through a lease, and oil and natural gas transmission pipelines and related facilities.

Mining claim: That portion of the public mineral lands which a miner, for mining purposes, takes and holds in accordance with the mining laws. A mining claim may be validly located and held only after the discovery of a valuable mineral deposit.

Mirror: A reflecting surface of various physical shapes (parabolic, nearly flat, or flat) used to reflect and/or concentrate the sun's energy to specific locations within solar energy facilities.

Mitigation: A method or process by which impacts from actions can be made less injurious to the environment through appropriate protective measures.

Mitigation measures: Methods or actions that will reduce adverse impacts from solar facility development. Mitigation measures can include best management practices, stipulations in BLM ROW agreements, siting criteria, and technology controls.

Module: *See* Photovoltaic (PV) module.

Multijunction solar cell: A photovoltaic device comprised of two or more semiconductor materials or cell junctions, each capable of producing electricity with the photovoltaic effect by absorbing solar energy from different wavelengths of the solar spectrum. Multijunction solar cells can convert sunlight to electricity at greater overall efficiencies than single-junction cells.

Multiple use: A combination of balanced and diverse resource uses that takes into account the long-term needs of future generations for renewable and nonrenewable resources, including (but not limited to) recreation, range, timber, minerals, watershed, wildlife, and fish, along with natural scenic, scientific, and historical values.

Nameplate rating: The maximum power-generating capacity of a generator or power-generating facility.

National Ambient Air Quality Standards (NAAQS): Air quality standards established by the Clean Air Act, as amended. The primary NAAQS are intended to protect the public health with an adequate margin of safety; and the secondary NAAQS are intended to protect the public welfare from any known or anticipated adverse effects of a pollutant.

National Conservation Lands: Lands managed by BLM and designated by Congress to conserve, protect, enhance, and manage the public lands for the benefit and enjoyment of present and future generations. They include National Monuments, National Conservation Areas, Wilderness Areas, Wilderness Study Areas, Wild and Scenic Rivers, National Scenic and Historic Trails, and Conservation Lands of the California Desert.

National Environmental Policy Act of 1969 (NEPA): Legislation that requires federal agencies to prepare a detailed statement on the environmental impacts of their proposed major actions that are significantly affecting the quality of the human environment.

National Historic Preservation Act (NHPA): A federal law providing that property resources with significant national historic value be placed on the *National Register of Historic Places*. It does not require permits; rather, it mandates consultation with the proper agencies whenever it is determined that a proposed action might impact an historic property.

National Historic Trails: Paths designated by Congress under the National Trails System Act of 1968 that follow, as closely as possible, on federal land, the original trails or routes of travel that have national historical significance.

National Pollutant Discharge Elimination System (NPDES): A federal permitting system controlling the discharge of effluents to surface water and regulated through the Clean Water Act, as amended.

National Recreation Area: An area designated by Congress to assure the conservation and protection of natural, scenic, historic, pastoral, fish, and wildlife values, and to provide for the enhancement of recreational values.

***National Register of Historic Places* (NRHP):** A comprehensive list of districts, sites, buildings, structures, and objects that are significant in American history, architecture, archaeology, engineering, and culture. The NRHP is administered by the National Park Service, which is part of the Department of the Interior.

National Scenic Byway: *See* All-American Roads.

Native American: Of, or relating to, a Tribe, people, or culture that is indigenous to the United States. (*See* Native American Graves Protection and Repatriation Act).

Native American Graves Protection and Repatriation Act (NAGPRA): Law that established the priority for ownership or control of Native American cultural items excavated or discovered on federal or Tribal land after 1990 and the procedures for repatriation of items in federal possession. The act allows for the intentional removal or excavation of Native American cultural items from federal or Tribal lands only with a permit or upon consultation with the appropriate tribe.

NPGPRA 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.

Neotropical migrants: Birds (especially songbirds) that summer in North America but migrate to the tropics for the winter.

Nonattainment area: The EPA's designation for an air quality control region (or portion thereof) in which ambient air concentrations of one or more criteria pollutants exceed National Ambient Air Quality Standards.

Notice of Intent: A public notice that an agency will prepare and consider an environmental impact statement.

Obligate species: Restricted to a particular condition of life; for example, dependent on a particular habitat to be able to breed. *See also* riparian obligate; sand-dune obligate.

Oil and gas leasing (on BLM land): BLM-issued permits of oil and gas rights to explore for and produce oil and gas resources from federal lands or mineral rights owned by the federal government. Federal oil and gas leases may be obtained and held by any adult citizen of the United States.

Onroad mobile source (emissions): Any mobile source of air pollution such as cars, trucks, motorcycles, and buses that travels on roads and highways.

Overdraft: The pumping of water from a groundwater basin or aquifer in excess of the supply flowing into the basin; resulting in a depletion or mining of the groundwater in the basin.

Paleontological resources: Fossilized remains, imprints, and traces of plants and animals preserved in rocks and sediments since some past geologic time.

Parabolic trough: A type of CSP solar energy technology that uses parabolic-shaped mirrors to concentrate sunlight on a receiver filled with a heat transfer fluid that subsequently transfers the heat it absorbs to water to produce steam to drive a steam turbine-generator (STG) to produce electricity. Parabolic trough systems typically mount the mirrors on a support that can track the sun's movement across the sky over the course of the day, ensuring maximum solar energy capture.

Particulate matter: Fine solid or liquid particles such as dust, smoke, mist, fumes, or smog, found in air or emissions. The size of the particulates is measured in micrometers (µm). One micrometer is 1 millionth of a meter or 0.000039 inch. Particle size is important because the EPA has set standards for $PM_{2.5}$ and PM_{10} particulates.

Peak horizontal acceleration: A measure of earthquake acceleration (i.e., shaking) on the ground surface expressed in g, the acceleration due to the Earth's gravity.

Perennial/safe/sustainable yield: A specified rate of groundwater pumping that can be sustained for an indefinite period of time without impairing hydrogeologic and ecologic processes, characteristics, or functions existing within a groundwater basin. Examples of impacts to hydrogeologic and ecologic processes, characteristics, and functions include (but are not limited to) alterations to basin-scale flow paths (direction and magnitude); significant drawdown of groundwater surface elevations; decreases in hydrostatic pressures; and decreased connectivity with surface features such as springs, wetlands, and phreatic vegetation. Quantifying perennial/safe/sustainable yields is a non-trivial task that is often performed by examining basin-scale information on groundwater recharge, discharge, and storage processes obtained through the combination of extensive field-data collection and numerical modeling.

Permittee: An individual who holds either a BLM grazing permit or grazing lease that authorizes grazing use of the public lands issued under authority of Section 3 or 15 of the Taylor Grazing Act of June 28, 1934, as amended (TGA). Although an individual holding an authorization under Section 3 of the TGA is technically a permittee, an individual holding an authorization under Section 15 of the TGA holds a lease and is a lessee. For the purpose of the Solar PEIS, both permittees and lessees are referred to as permittees.

Phosphorous: A chemical element used as a dopant in making n-type semiconductor layers. An essential chemical food element that can contribute to the eutrophication of lakes and other water bodies. Increased phosphorus levels result from discharge of phosphorus-containing materials into surface waters.

Photovoltaic (PV) array: An interconnected system of PV modules that functions as a single electricity-producing unit. The modules are assembled as a discrete structure, with common support or mounting. In smaller capacity systems, an array can consist of a single module.

Photovoltaic (PV) cell: The smallest semiconductor element within a PV module that converts incident sunlight into electrical energy (direct current voltage and current). Also called a solar cell.

Photovoltaic (PV) facility: A solar energy facility that uses photovoltaic cells to produce electricity and that includes all components, such as the PV system, power conditioning equipment, monitoring and control capabilities, and other features required for safe connection of the facility to the bulk electricity transmission grid, as well as buildings, access roads, perimeter fence, and other equipment needed for operation and maintenance of the facility.

Photovoltaic (PV) module: An assembly of solar cells (flat-plate type) or receiver(s), optics (concentrator type), and ancillary parts, such as interconnects and terminals, enclosed in a weatherproof container, intended to generate DC power under unconcentrated sunlight. (Note: A CPV module is a concentrator type PV module.) The structural (load carrying) member of a module can either be the top layer (superstrate) or the back layer (substrate).

Photovoltaic (PV) panel: A collection of modules, either flat-plate or concentrator type, mechanically fastened, electrically interconnected, and designed to provide a field-installable unit. (Note: Not all PV systems will use panelized units during installation. Sometimes the modules are individually attached to a support structure.)

Photovoltaic (PV) power plant: *See* Photovoltaic (PV) facility.

Photovoltaic (PV) receiver: An assembly of one or more PV cells that accepts concentrated sunlight and incorporates means for thermal and electric energy removal.

Photovoltaic (PV) system: *See* Photovoltaic (PV) facility.

Photovoltaic (PV) technology: A solar energy technology that creates electrical power by directly converting the photons in sunlight to electricity.

Photovoltaics (PV): Technologies using semiconducting materials that convert sunlight directly into electricity.

Physiography: The physical geography of an area or the description of its physical features.

Piezometer: A non-pumping well, generally of small diameter, for measuring the elevation of a water table.

Planning area: The geographic area within which the BLM will make decisions during a planning effort. For this Programmatic EIS the planning area includes the following 11 states: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. BLM will make decisions only on lands that are under BLM jurisdiction.

Plan of Development: An applicant submits a plan of development when a solar ROW application is submitted to the BLM. The plan of development must include the project description, construction of facilities, related facilities and systems, operations and maintenance, environmental considerations, maps and drawings, and any supplemental information.

Playa: Flat areas that contain seasonal or year-to-year shallow lakes that often evaporate, leaving minerals behind. Playas form in arid basins where rivers merge, but do not drain.

$PM_{2.5}$: Particulate matter with a mean aerodynamic diameter of 2.5 micrometers (0.0001 inch) or less. Particles less than this diameter can lodge deeply in the lungs. $PM_{2.5}$ is one of the six criteria pollutants specified under Title I of the Clean Air Act.

PM_{10}: Particulate matter with a mean aerodynamic diameter of 10 micrometers (0.0004 inch) or less. Particles less than this diameter can be inhaled and accumulate in the respiratory system. PM_{10} is one of the six criteria pollutants specified under Title I of the Clean Air Act.

Potential Fossil Yield Classification (PFYC): Initially developed by the U.S. Forest Service and the Region 2 Paleo Initiative in May 1996, the PFYC system provides baseline guidance for assessing the relative occurrence of important paleontological resources and the need for mitigation. Specifically, it is used to classify geologic units, at the formation or member level, according to the probability that they could yield paleontological resources of concern to land managers.

Power conditioning system (PCS): In solar energy facilities, the collection of electrical equipment that converts direct current (DC) from a photovoltaic array to alternating current (AC) or that conditions AC current produced at CSP facilities to match the voltage and phase conditions of the bulk electricity grid to which the solar energy facility is connected; power conditioning systems also include system monitoring devices and isolation switches that can isolate the solar energy facility from the bulk electricity grid during off-normal conditions that could jeopardize or damage either the facility or the grid.

Power production capacity: The amount of power that a facility can produce under ideal operating conditions. *See also* Battery capacity.

Power purchase agreement (PPA): a long-term contract between an electricity generator and a customer, usually a utility, government, or company.

Power tower: A type of CSP technology composed of many large, sun-tracking mirrors (heliostats) that focus sunlight on a receiver at the top of a centrally located tower. The sunlight heats a heat transfer fluid in the receiver, which then is used to generate steam (or directly heats water to produce steam) that powers a steam turbine-generator (STG) to produce electricity. Power Tower facilities were evaluated in the 2012 Western Solar Plan but their use is not prevalent, so they are not evaluated in this Programmatic EIS.

Prehistoric: The time period before the appearance of written records. In the New World this generally refers to indigenous, precontact societies.

Prior Appropriation Doctrine: A system for allocating water rights used in the western United States under which the first person (or entity) to divert water from a source has a priority to that water right, and so on. Under the system of prior appropriation, water rights that are junior are not allowed to prevent senior water rights holders from obtaining their allocation of water. Thus, in times of drought, a junior water rights holder may not be entitled to its share of the resource. However, even senior water rights

holders are not allowed to change the time of use, place of use, purpose of use, or point of diversion of the right if it would injure other water rights holders within a basin.

Priority Species are identified in some BLM RMPs as fish or wildlife species that are considered significant for at least one factor such as density, diversity, size, public interest, remnant character, or age. Identify desired outcomes using BLM strategic plans, state agency strategic plans, and other similar sources.

Programmatic Environmental Impact Statement (PEIS): An evaluation of the effects of broad proposals or planning-level decisions that may include any or all of the following: a wide range of individual projects; implementation over a long timeframe; and or implementation across a large geographic area.

Properties of traditional religious and cultural importance to an Indian Tribe: Often referred to as "traditional cultural properties," these features may be eligible for listing on the *National Register.* They include sacred sites, burial grounds, ancestral sites, traditional gathering places, and culturally important landscapes and natural resources (36 CFR 800.16(l)(1)).

Proposed Action: A proposal for the BLM to authorize, recommend, or implement an action that addresses a purpose and need.

Public land: Any land and interest in land (outside of Alaska) owned by the United States and administered by the Secretary of the Interior through the Bureau of Land Management.

Public Land Order (PLO): An order affecting, modifying, or cancelling a withdrawal or reservation that has been issued by the Secretary of the Interior pursuant to powers of the President delegated to the Secretary by Executive Order 9146 of April 24, 1942, or 9337 of April 24, 1943.

Pueblo rights: A water right possessed by a municipality which, as a successor of a Spanish or Mexican pueblo, is entitled to the beneficial use of all needed, naturally-occurring surface and groundwater of the original pueblo watershed. Pueblo rights are paramount to all other claims.

Purpose and Need: Describes the problem or opportunity to which the BLM is responding and what the BLM hopes to accomplish by the action. The CEQ regulations direct that an EIS "...shall briefly specify the underlying purpose and need to which the agency is responding in proposing the alternatives including the proposed action."

Quaternary Faults: Pre-existing faults with evidence of movement or deformation within the past 1.6 million years.

Rangeland: Land on which the native vegetation, climax, or natural potential consists predominately of grasses, grasslike plants, forbs, or shrubs. Rangeland includes lands that are revegetated naturally or artificially to provide a plant cover that is managed similar to native vegetation. Rangelands may consist of natural grasslands, savannas,

shrub lands, most deserts, tundra, alpine communities, coastal marshes, and wet meadows.

Receiver: A component of a solar energy facility that receives solar energy and converts it to useful energy forms, typically heat.

Receptor: A location where environmental resources such as air concentration or noise level are evaluated (e.g., property boundaries, residences, schools, hospitals, libraries).

Recharge: The addition of water to an aquifer by natural infiltration (e.g., rainfall that seeps into the ground) or by artificial injection through wells.

Reclamation: The process of restoring surface environment to acceptable pre-existing conditions.

Record of Decision (ROD): A document separate from but associated with an EIS that publicly and officially discloses the responsible agency's decision on the EIS alternative to be implemented.

Reflector: A component of a solar energy facility that reflects incident sunlight to a desired location or component within the facility, allowing it to be converted to other useful forms of energy, typically heat.

Reserved Water Right: A special water right accompanying federal lands (military reservations, national parks, forests, or monuments) or Indian reservations. Federal reserved water rights have a priority date originating with the creation of the federal land or reservation and may be used in the future in the amount necessary to fulfill the purpose of the federal land or reservation.

Resource Conservation and Recovery Act (RCRA): An amendment to the Solid Waste Disposal Act, RCRA (42 U.S.C. 6901 et seq.), which authorizes the development of federal regulations for the definition, storage, treatment, and disposal of solid wastes and hazardous wastes, as well as the process by which states may obtain primacy for implementation of the federal program.

Resource Management Plan (RMP): A land use plan that establishes land use allocations, multiple use guidelines, and management objectives for a given planning area. The RMP planning system has been used by the Bureau of Land Management since about 1980.

Right-of-way (ROW): The legal right to cross the lands of another. Also used to indicate the strip of land for a road, railroad, or power line. In BLM, a permit or an easement that authorizes the use of public lands for certain specified purposes- also, , the lands covered by such an easement or permit. The authorization to use a particular parcel of public land for specific facilities for a definite time period. Authorizes the use of a ROW over, upon, under, or through public lands for construction, operation, maintenance, and termination of a project.

Rinsate: Water that is used to rinse or clean equipment or reaction vessels and that may, as a result, become contaminated and require special handling and disposal.

Riparian: Relating to, living in, or located on the bank of a river, lake, or tidewater.

Sacred site: 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.

Safe Drinking Water Act (SWDA): Act authorizing development of maximum contaminant levels for drinking water applicable to public water systems (i.e., systems that serve at least 25 people or have at least 15 connections).

Safe yield: The amount of groundwater that can be withdrawn from a groundwater basin over a period of time without exceeding the long-term recharge of the basin or unreasonably affecting the basin's physical and chemical integrity. *See also* Perennial/safe/sustainable yield.

Sanitary waste: Nonhazardous, nonradioactive liquid and solid waste generated by normal housekeeping activities.

Sanitary wastewater: Wastewater (includes toilet, sink, shower, and kitchen flows) generated by normal housekeeping activities.

Scenic integrity: The degree of "intactness" of a landscape, which is related to the existing amount of visual disturbance present. Landscapes with higher scenic integrity are generally regarded as more sensitive to visual disturbances.

Scenic quality: A measure of the intrinsic beauty of landform, water form, or vegetation in the landscape, as well as any visible human additions or alterations to the landscape.

Scenic resources: The visible physical features on a landscape (e.g., land, water, vegetation, animals, structures, and other features). Also referred to as visual resources.

Scenic value: The importance of a landscape based on human perception of the intrinsic beauty of landform, water form, and vegetation in the landscape, as well as any visible human additions or alterations to the landscape.

Scoping: The process of inviting public comment on what should be considered prior to preparation of an EIS. Scoping assists the preparers of an EIS in defining the proposed action, identifying alternatives, and developing preliminary issues to be addressed in an EIS.

Sedimentation: The removal, transport, and deposition of sediment particles by wind or water.

Seeps: Wet areas, normally not flowing, arising from an underground water source. Any place where liquid has oozed from the ground to the surface.

Seismicity: Refers to the geographic and historical distribution of earthquakes.

Semiconductor: Any material that has a limited capacity for conducting an electric current. Certain semiconductors, including silicon, gallium arsenide, copper indium diselenide, and cadmium telluride, are uniquely suited to the photovoltaic conversion process.

Sensitive species: A plant or animal species identified as sensitive by the BLM. BLM sensitive species are identified at the state-level and are generally those species that are native, occur on BLM lands, and require special management consideration to avoid potential future listing under the ESA.

The list of BLM sensitive species varies from state to state, and the same species can be considered sensitive in one state but not in another. Also, a species that is adversely affected by disturbance or altered environmental conditions, such as sedimentation. *See also* Special status species.

Silicon: A semi-metallic chemical element that makes an excellent semiconductor material for photovoltaic devices. It crystallizes in a face-centered cubic lattice similar to a diamond. It is commonly found in sand and quartz (as oxide).

Social disruption: Social and psychological dislocation associated with the alteration or breakdown of social life in small rural communities that may occur as a result of rapid economic and demographic change with rapid industrial and natural resource development.

Socioeconomics: The social and economic conditions in the study area.

Soil compaction: Compression of the soil which results in reduced soil pore space (the spaces between soil particles), decreased movement of water and air into and within the soil, decreased soil water storage, and increased surface runoff and erosion.

Soil horizon mixing: Soil horizon mixing occurs when soil is disturbed by activities such as excavation.

Solar application areas: Areas where applications for utility-scale solar energy development will be received.

Solar array: *See* Photovoltaic (PV) array.

Solar cell: *See* Photovoltaic (PV) cell.

Solar emphases areas: Areas that are well suited for utility-scale solar energy development. They are considered to be designated leasing areas.

Solar energy: Electromagnetic energy emitted from the sun (solar radiation). The amount that reaches the Earth is equal to one billionth of total solar energy generated, or the equivalent of about 420 trillion kilowatt-hours.

Solar energy technology: Any engineered method for harnessing, storing, and using the sun's energy.

Solar Energy Zone (SEZ): Lands identified by the BLM as best-suited for large-scale production of solar energy.

Solar insolation values: The solar radiation that reaches the earth's surface, typically represented as energy density and measured in units of watts per square meter (W/m^2) [joules/ft^2] per minute.

Solar module: *See* Photovoltaic (PV) module.

Solar panel: *See* Photovoltaic (PV) panel.

Solar tracking: Solar panels that can be swiveled using electric motors to follow the path of the sun exactly in the course of the day to maximize the yields.

Sole source aquifer: An aquifer that supplies 50 percent or more of an area's drinking water.

Solid waste: All unwanted, abandoned, or discarded solid or semisolid material, whether or not subject to decomposition, originating from any source.

Source: Any place or object from which air pollutants are released. Sources that are fixed in space are stationary sources and sources that move are mobile sources.

Special status species (threatened, endangered, sensitive, rare): Include (BLM Manual 6840 Rel. 6-125, or as revised): (1) species listed as threatened or endangered under the ESA; (2) species that are proposed for listing or candidates for listing under the ESA; (3) federally delisted species (within 5 years of delisting) and; (4) species that are listed by the BLM as sensitive.

Special Use Airspace (SUA): Airspace of defined dimensions identified by an area on the surface of the Earth wherein activities must be confined because of their nature and/or wherein limitations may be imposed upon aircraft operations that are not a part of those activities.

Specially Designated Areas: Includes a variety of areas that have received recognition or designation because they possess unique or important resource values. While these areas would not be available for development of solar energy resources, they could be located near solar development areas and could be affected by solar development. Examples of BLM-administered specially designated areas include components of the BLM National Landscape Conservation System (NLCS), areas of critical environmental concern (ACECs), special recreation management areas, and areas with wilderness values. These areas may have been designated by Congress or by the BLM. The majority of specially designated areas discussed in this PEIS are located on BLM-administered public lands; however, some specially designated areas managed by the U.S. Forest Service (USFS), U.S. Fish and Wildlife Service (USFWS), National Park

Service, and states also are included in the analysis when they could be affected by solar development on public lands.

Species of Special Concern: A species that may have a declining population, limited occurrence, or low numbers for any of a variety of reasons.

Spill light: Light that falls outside of the area intended to be lighted.

Staging area: A designated area where construction equipment is temporarily stored (usually only during the construction phase).

State Historic Preservation Officer (SHPO): The state officer charged with the identification and protection of prehistoric and historic resources in accordance with the National Historic Preservation Act.

Stratigraphy (stratigraphic): Layers of sediments and rocks that reflect the geologic history of an area. With respect to cultural resources and archaeological sites, the relative stratigraphic locations of human artifacts help determine the sequence in which past human activities took place.

Stressors: Physical, chemical, or biological entities that can induce adverse effects on ecosystems or human health.

Subsidence: Sinking or settlement of the land surface, due to any of several processes. As commonly used, the term relates to the vertical downward movement of natural surfaces although small-scale horizontal components may be present. The term does not include landslides, which have large-scale horizontal displacements, or settlements of artificial fills.

Substation: A substation consists of one or more transformers and their associated switchgear. It is used to switch generators, equipment, and circuits or lines in and out of a system. It is also used to change AC voltages from one level to another.

Surface water: Water on the Earth's surface that is directly exposed to the atmosphere, as distinguished from water in the ground (groundwater).

Sustainable yield: *See* Perennial/Safe/Sustainable yield.

Texture: For visual effects assessment, the visual manifestations of light and shadow created by the variations in the surface of an object or landscape.

Thermoelectric (power) water use: Water used in generating electricity with steam-driven turbine generators. Power plants that burn coal and oil are examples of thermoelectric-power facilities. Production of electrical power results in one of the largest uses of water in the United States and worldwide.

Thin film: A layer of semiconductor material, such as copper indium diselenide or gallium arsenide, a few microns or less in thickness, used to make photovoltaic cells.

Threatened species: Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. Requirements for declaring a species threatened are contained in the Endangered Species Act. *See also* Special Status Species.

Traditional cultural property: A property that is eligible for inclusion in the *National Register of Historic Places* based on its association with cultural practices, traditions, beliefs, lifeways, arts, crafts, or social institutions of a living community. Traditional Cultural Properties are rooted in the community's history and are important in maintaining the continuing cultural identity of the community.

Translocation: The intentional capture, movement, and release of individuals of a species into a different area, usually to prevent harm to the individuals or to establish populations elsewhere.

Transmission corridor: An electric or pipeline transmission corridor is a route approved on public lands, in a BLM or other federal agency land use plan, as a location that may be suitable for the siting of electric or pipeline transmission systems.

Transmission get-tie projects: An interconnection from a solar energy project (or any energy generating system) to the utility transmission grid system.

Transmission grid: The transmission and distribution network used to deliver electricity. The transmission grid comprises power stations, transmission lines, and substations.

Transmission line: A set of electrical current conductors, insulators, supporting structures, and associated equipment used to move large quantities of power at high voltage, usually over long distances (e.g., between a power plant and the communities that it serves).

Treaty Rights: Rights reserved to Native Americans by treaties, including hunting, fishing, gathering, and mineral rights.

Tribal lands: All lands within the exterior boundaries of an Indian reservation and all dependent Indian communities (36 CFR 800.16(x)).

Tribe: A federally recognized group of American Indians and their governing body. Tribes may be composed of more than one band.

Turbidity: A measure of the cloudiness or opaqueness of water. Typically, the higher the concentration of suspended material, the greater the turbidity.

***United States Code* (U.S.C.):** A compilation of the general and permanent federal laws of the United States. It is divided into 51 titles that represent broad areas subject to federal regulation. The U.S.C. is updated once every six years, and supplements are published on an annual basis.

Upland: The portion of the landscape above the valley floor or stream.

U.S. Environmental Protection Agency: An independent federal agency, established in 1970, that regulates federal environmental matters and oversees the implementation of federal environmental laws.

Utility-scale facilities: Facilities that generate large amounts of electricity delivered to many users through transmission and distribution systems.

Ultralight flightparks: Airports specifically used only for ultralight vehicles.

Variance/Variance process: For the six states covered under the 2012 Western Solar Plan, utility-scale solar energy development is allowed in variance areas (areas identified as appropriate for solar energy development) outside of SEZs in accordance with the established variance process. Lands identified as components of the variance process include a number of required steps including a variance determination where the BLM determines whether it is appropriate to continue to process, or to deny, a ROW application submitted through the variance process.

Viewshed: The total landscape seen or potentially seen from all or a logical part of a travel route, use area, or water body.

Visual impact: Any modification in land forms, water bodies, or vegetation, or any introduction of structures, which negatively or positively affect the visual character or quality of a landscape through the introduction of visual contrasts in the basic elements of form, line, color, and texture.

Visual quality: *See* Scenic quality.

Visual resources: All objects (man-made and natural, moving and stationary) with features such as landforms and water bodies that are visible on a landscape.

Visual Resource Inventory (VRI): Consists of a scenic quality evaluation, sensitivity level analysis, and a delineation of distance zones. Based on these three factors, BLM-administered lands are placed into one of four visual resource inventory classes.

Visual Resource Inventory (VRI) Classes: VRI Classes are assigned to public lands based upon the results from the Visual Resource Inventory. They do not establish management direction and should not be used as a basis for constraining or limiting surface disturbing activities. Inventory classes are informational in nature and provide the basis for considering visual values in the RMP process. There are four classes (I, II, III, and IV).

Visual Resource Management (VRM) Classes: Categories assigned to BLM lands, utilizing the Visual Resource Inventory Classes in the RMP process, with an objective which prescribes the amount of change allowed in the characteristic landscape. All actions proposed during the RMP process that would result in surface disturbances must consider the importance of the visual values and the impacts the project may have on these values. Management decisions in the RMP must reflect the value of visual resources. The value of the visual resource may be the driving force for some management decisions. There are four VRM classes: I, II, III and IV.

Visual Resource Management (VRM) Class Designations: Class I objective is to preserve the existing character of the landscape. The level of change to the characteristic landscape should be very low and must not attract attention. **Class II** objective is to retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen but must not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural landscape features. **Class III** objective is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements of form, line, color, and texture found in the predominant natural landscape features. **Class IV** objective is to provide for management activities that require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high.

Visual Resource Management (VRM) System: BLM's system for minimizing the visual impacts of surface-disturbing activities and maintaining scenic values for the future. The inventory and planning actions taken to identify visual values and to establish objectives for managing those values; and the management actions taken to achieve the visual management objectives.

Visual value: *See* Scenic value.

Waste management: Procedures, physical attributes, and support services that collectively provide for the identification, containerization, storage, transport, treatment (as necessary), and disposal of wastes generated in association with an activity.

Wastewater: Water that typically contains less than 1% concentration of organic hazardous waste materials. Water originating from human sanitary water use (domestic wastewater) and from a variety of industrial processes (industrial wastewater).

Water quality: A term used to describe the chemical, physical, and biological characteristics of water, usually with respect to its suitability for a particular purpose.

Water right: A legal entitlement of an individual or entity to extract water from a water source (surface water or groundwater) and to use it for a beneficial use (e.g., potable water supply, irrigation, mining, livestock).

Watershed: A region or area bounded peripherally by water parting and draining ultimately to a particular water-course.

Watt (W): A basic unit of power; one joule of energy consumed per second. When used to describe electrical power, one watt is the product of voltage times current.

Wetlands: Areas that are soaked or flooded by surface or groundwater frequently enough or long enough to support plants, birds, animals, and aquatic life. Wetlands generally include swamps, marshes, bogs, estuaries, and other inland and coastal areas and are federally protected.

Wild and Scenic Rivers (WSR) Act: Primary river conservation law enacted in 1968. The Act was specifically intended by Congress to balance the existing policy of building dams on rivers for water supply, power, and other benefits, with a new policy of protecting the free-flowing character and outstanding values of other rivers.

Wild Free-Roaming Horses and Burros Act of 1971: Act passed by Congress in 1971 giving BLM the responsibility to protect, manage, and control wild horses.

Wild horses and burros: Unbranded and unclaimed horses or burros roaming free on public lands in the western United States and protected by the Wild Free-Roaming Horse and Burro Act of 1971. They are descendants of animals turned loose by, or escaped from, ranchers, prospectors, Indian Tribes, and the U.S. cavalry from the late 1800s through the 1930s.

Wilderness / Wilderness Areas: All lands included in the National Wilderness Preservation System by public law, generally defined as undeveloped federal land retaining its primeval character and influence without permanent improvements or human habitation.

Wilderness characteristics: Wilderness characteristics include (1) Naturalness: the area generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) Outstanding Opportunities: the area has either outstanding opportunities for solitude, or outstanding opportunities for primitive and unconfined types of recreation; (3) Size: the area is at least 5,000 acres (20 km^2) of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) Values: the area may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.

Wildlife corridor: Linear spaces that connect various areas of an animal's habitat (e.g., links between feeding, watering, resting, breeding, or seasonal habitats).

Wind rose: A circular diagram, for a given locality or area, showing the frequency and strength of the wind from various directions over a specified period of record.

Withdrawal: The removal of surface water or groundwater from the natural hydrologic system for use, including: public-water supply, industry, commercial, domestic, irrigation, livestock, or thermoelectric power generation.

Xeric (habitat): Low in moisture. Dry environmental conditions. Habitats or sites characterized by their limited water availability.