3.10 ENERGY RESOURCES

3.10.1 INTRODUCTION

The analyses in this section consider two specific issues associated with energy resources. The first issue considered is potential changes in hydropower production from Hoover Dam and Glen Canyon Dam; the second is potential increases in energy requirements of the Southern Nevada Water System (SNWS) Lake Mead intake, Navajo Generating Station cooling water intake in Lake Powell and the City of Page potable water intake in Lake Powell.

3.10.2 HYDROPOWER

This section discusses potential changes in power production that could occur as a result of the interim surplus criteria under consideration. The analysis focuses on changes in production from Glen Canyon Dam and Hoover Dam for each alternative compared to baseline conditions.

3.10.2.1 METHODOLOGY

In order to determine the effects of the interim surplus criteria alternatives, the information produced from the river system modeling described in detail in Section 3.3 has been used. This model simulates operation of Glen Canyon and Hoover powerplants under baseline conditions and the interim surplus criteria alternatives. The output quantities of the model that are important in determining the effects of the alternatives on power generation are:

- Annual average Lake Powell Elevation;
- Annual average Glen Canyon Powerplant Energy Production;
- Annual average Lake Mead Elevation;
- Annual average Hoover Powerplant Energy Production;
- Annual average Lake Mohave Elevation (constant at an elevation of 647 feet msl throughout the period of analysis).

These quantities, derived from the model runs, are shown in Tables 1, 2, 5 and 7 in Attachment P. In addition, powerplant capability curves for Glen Canyon and Hoover powerplants showing powerplant capacity as a function of lake elevation (or net effective head) are required to determine how the capacity varies for each alternative throughout the study period. Powerplant capability curves used for the analysis are presented in Tables 3 and 4 in Attachment P.

Table 3 of Attachment P uses discharge multipliers to determine the maximum operable capacity of the Glen Canyon Powerplant. The maximum water release of 25,000 cfs (restricted except during power system emergencies) is divided by the discharge multiplier to calculate the capacity. Table 4, for Hoover Powerplant, uses the theoretical turbine curve data for heads from 560 feet to 590 feet. Below 560 feet of head, a ratio of 2062/2074 has been applied to the turbine curve data to reflect recent downratings of units A3, A4, and A8 as reported in a letter dated July 2000, from the Area Manager of Reclamation to Western.

As used herein, powerplant capacity refers to the load that a generator or facility can achieve at a given moment. Energy is a measure of electric capacity generated over time. Comparing the projected amount of powerplant generating capacity and energy production available under the various alternatives with baseline projections produces a probabilistic measure of the effects of the alternatives on power production if the assumptions contained in the forecasts covering water supply materialize.

The methodology for determination of the effects of the alternatives is to compare the change in capacity and energy production, on an annual basis, between baseline conditions and each alternative. Annual average generating capacity and energy available from Glen Canyon and Hoover powerplants was determined using the reservoir elevation and energy output quantities from system modeling discussed in Section 3.3, and the powerplant capability curves. Modeling of energy production is based on aggregate turbine production curves. Annual average capacity and energy production for baseline conditions and the alternatives are shown in Tables 5 and 7 in Attachment P. Annual average energy production is also shown in Figures 3.10-1 and 3.10-2. Comparisons of the annual average energy production associated with each alternative and the annual average energy production of baseline conditions are shown in Tables 6 and 8 in Attachment P.

3.10.2.2 AFFECTED ENVIRONMENT

The energy resources that could be affected by changes in Colorado River operation are Glen Canyon Powerplant and Hoover Powerplant electrical power output. The reservoirs behind these facilities are operated to store Colorado River water for delivery in the Lower Colorado River Basin below Glen Canyon Dam, and water to meet delivery obligations to Arizona, California, Nevada and Mexico downstream of Hoover Dam.

3.10.2.2.1 Factors of Power Production

In general, the two factors of a hydroelectric system, excluding machinery capability, that are directly related to power production are the net effective head on the generating units, and the quantity of water flowing through the turbines.

The net effective head is the difference between the water surface elevations of the forebay behind a dam and in the tailwater below the dam. The head determines the maximum capacity, measured in MW, that is available from the powerplant. The nameplate capacity of Glen Canyon Powerplant is 1296 MW. However, the maximum operating capacity of Glen Canyon Powerplant generators is approximately 1200 MW due to turbine restrictions (Western, 1998). Because the maximum allowable water release has been limited to 25,000 cfs, the maximum operable capacity for Glen Canyon is limited to 1048 MW, except during a power system emergency. The maximum operating capacity of Hoover Powerplant is 2074 MW. The net effective head on the powerplant is influenced by the reservoir surface elevations and operating strategies for both the upstream and downstream reservoirs.

The quantity of water flowing through the turbines (water releases) determines the amount of energy produced, measured in gigawatt-hours (GWh). The net energy generated during fiscal year 1998 from Glen Canyon Powerplant and Hoover Powerplant was 6626 GWh and 5768 GWh, respectively (Western, 1998 and Reclamation, 2000).

The turbines at a powerplant are designed to produce maximum efficiency at a design head. At design head, the plant can produce the maximum capacity and the most energy per acre-foot of water passing through the turbine. As the net effective head on the powerplant is reduced from design head because of reduced forebay (upstream reservoir) elevation, the power output of the turbine is reduced, the electrical capacity of the generator attached to the turbine is reduced, and the efficiency of the turbine is reduced. This reduction continues as net effective head decreases until, below the minimum elevation for power generation, the turbines cannot be operated safely and must be bypassed for downstream water deliveries. Minimum power elevation generally occurs at a point where cavitation within the turbine causes extremely rough operation, air may become entrained in the water, and/or vortices may appear in the forebay.

3.10.2.2.2 Power Marketing and Customers

The effects of any surplus or deficit in power generation are incurred by the customers to whom the power from Glen Canyon and Hoover powerplants is allocated. The contracts for power from Glen Canyon Dam terminate in 2025. The contracts for power from Hoover Dam terminate in 2017. The identity of the recipients of power from these resources is not known for about two-thirds of the period of analysis for Hoover Dam and about one-half of the period of analysis for Glen Canyon Dam. Therefore, an analysis of the effects of the alternatives compared with those of baseline conditions will consider the general effects in the overall areas served by the resources, although a future group of power customers would be impacted similarly to current customers.

The states that would be affected by changes in energy and capacity at Glen Canyon and Hoover powerplants are Arizona, California, Nevada, Utah, Wyoming, New

Mexico and Colorado. These states make up the Rocky Mountain, Arizona-New Mexico-Southern Nevada, and California-Mexico areas of the Western Systems Coordinating Council (WSCC). Electrical energy produced in each of these areas is derived from a variety of sources. The power from Glen Canyon Powerplant and Hoover Powerplant contributes a small, but significant portion of the energy produced in these areas. The total generation capability of the areas as of January 1, 1999, is 86,348 MW. The generation capability of each WSCC area is:

- Rocky Mountain 10,584 MW
- Arizona-New Mexico-Southern Nevada 22,272 MW
- California-Mexico 53,492 MW

Glen Canyon and Hoover powerplants contribute approximately 3.6 percent of the total generating capability of these three areas of WSCC (WSCC, 1999). The maximum capacity available from Glen Canyon Powerplant at elevation 3700 feet msl has been restricted to approximately 1200 MW. However, as stated above, the maximum operable capacity at Glen Canyon Powerplant is limited to 1048 MW due to water release restrictions, except during power system emergencies. Therefore, for the purposes of this analysis, the operable capacities of Hoover and Glen Canyon powerplants are 2074 MW and 1048 MW, respectively, for a total of 3122 MW.

3.10.2.3 ENVIRONMENTAL CONSEQUENCES

The environmental consequences of a change in river operations that impacts power production can be measured by the increase or decrease in capacity and energy available from the powerplants. The power production under the alternatives is compared with power production under baseline conditions to determine the incremental effects of each alternative, using annual average modeled reservoir levels and downstream releases. Reductions in capacity, energy, and generation ancillary services from Glen Canyon and Hoover powerplants under baseline conditions would ultimately need to be replaced by either types of generation. Additional incremental reductions under each alternative would also ultimately need to be replaced.

The replacement of Glen Canyon and Hoover powerplant generation could be accomplished through a number of different strategies. If capacity loss can be expected for long periods of time, construction of new generation would likely occur. If capacity loss is intermittent throughout the period of analysis, purchases from the short-term market would be expected. If energy loss can be expected for a long period of time, either construction of new generation or operation of higher-cost generation for longer periods of time during the day would be expected. If energy loss is intermittent throughout the period of analysis, replacement from the short-term market would be anticipated.

3.10.2.3.1 Baseline Conditions

3.10.2.3.1.1 Glen Canyon Dam

The annual average capacity and energy production at Glen Canyon Dam under baseline projections are shown in Table 5 in Attachment P; the annual average energy production is shown in Figure 3.10-1. The powerplant capacity begins at 1020 MW in 2002 and is reduced to 960 MW in 2016 because of reductions in lake elevation. Subsequently, the capacity increases to 990 MW in 2041, then decreases to 975 MW in 2050. From 2002 through 2016, the greatest annual decrease in capacity is 13 MW between 2012 and 2013. The annual reduction throughout the early years is from two to six MW, representing less than a one percent decline in capacity from the powerplant per year. The output varies cyclically between 2017 and 2050, with annual increases or decreases in capacity of two to six MW.

Under baseline conditions, the energy available from Glen Canyon Dam averages 4532 GWh from 2002 through 2016, and 4086 GWh through the rest of the period of analysis. Energy production increases the first year of the study. Thereafter, annual reductions in energy production are generally less than 50 GWh per year through 2016. Annual reductions in energy from 2017 through 2050 are generally less than 40 GWh.

3.10.2.3.1.2 Hoover Dam

The annual capacity and energy production at Hoover Powerplant under baseline conditions are shown in Table 7 of Attachment P; the annual average energy production is shown in Figure 3.10-2. The powerplant capacity begins at 2062 MW in 2002 and is reduced to 2033 MW in 2016 because of reductions in lake elevation. Capacity decreases to 1865 MW in the year 2050. From 2002 through 2016, the greatest annual decrease in capacity is nine MW. This reduction represents less than a one percent per year decline in capacity from the powerplant through 2016. From 2017 through the remainder of the period of analysis, the annual capacity reductions are generally less than 10 MW.

The energy available from Hoover Powerplant averages 4685 GWh from 2002 through 2016, and 3903 GWh through the rest of the period of analysis. Energy production increases during the first three years of the period of analysis, with annual reductions from 2004 through 2016 of generally less than 50 GWh. Annual reductions in energy from 2017 through 2050 are predominantly less than 60 GWh.

Figure 3.10-1
Glen Canyon Powerplant
Annual Average Energy Production

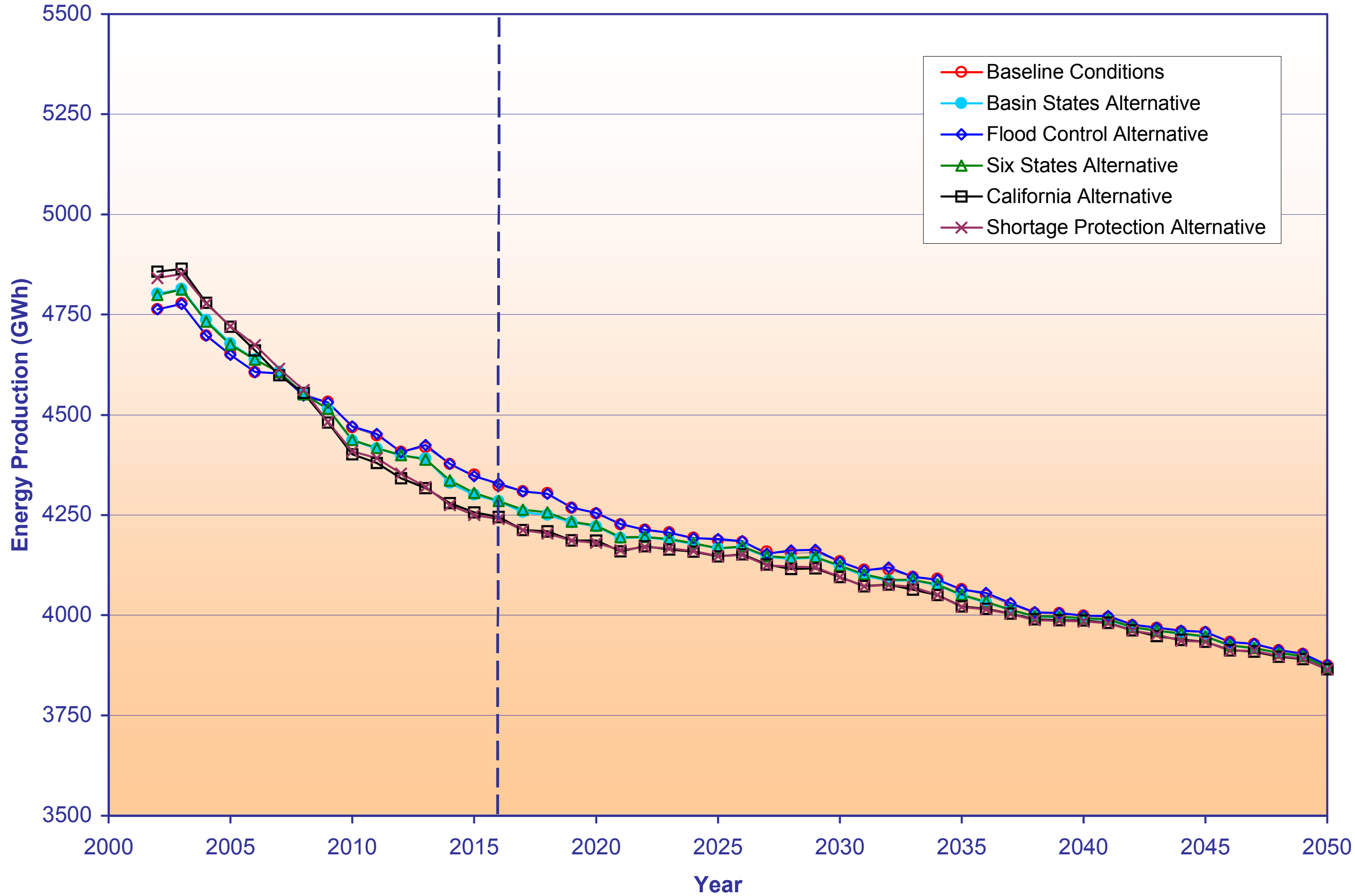
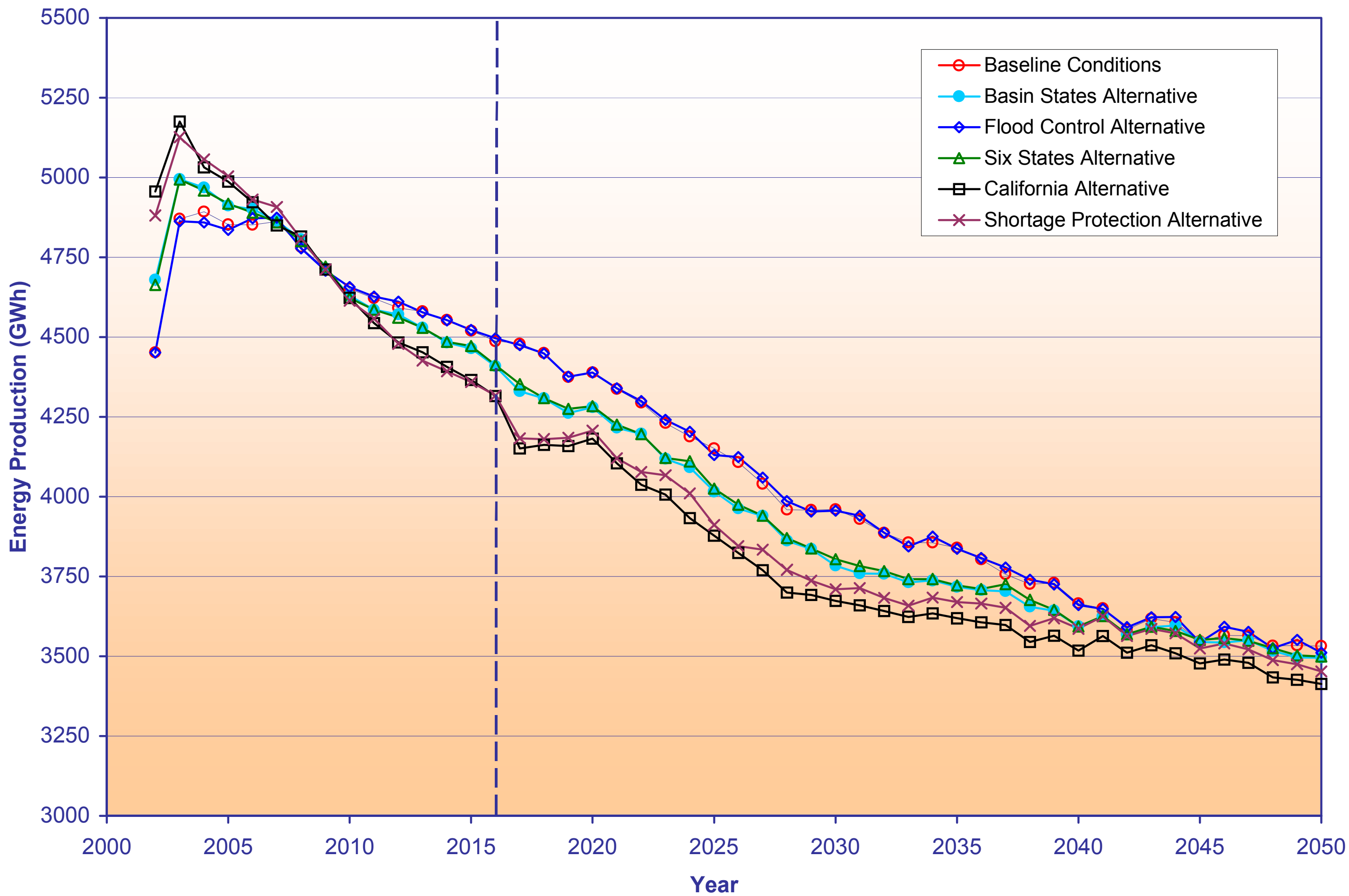


Figure 3.10-2
Hoover Powerplant
Annual Average Energy Production



3.10.2.3.1.3 Combined Capacity and Energy Reduction Under Baseline Conditions

The combined capacity reduction from Glen Canyon and Hoover powerplants through 2016 is 89 MW under baseline conditions. The combined energy production in 2016 is 403 GWh less than year 2002 energy production. In 2050, the capacity reduction is 242 MW less than 2002 levels, and the energy available is reduced 1807 GWh from year 2002 production. Under baseline conditions, power customers can expect a reduction in production from present levels in the future. Because of the gradual withdrawal over time, the deficit is expected to be replaced by short-term purchases made by either the power customers or Western, at the power customer’s option, in accordance with contract terms.

3.10.2.3.2 Basin States Alternative

3.10.2.3.2.1 Glen Canyon Dam

The average capacity available from Glen Canyon Powerplant under the Basin States Alternative is shown in Table 5 of Attachment P. The powerplant capacity begins at 1014 MW in 2002 and is reduced to 960 MW in 2016. The capacity varies two to four MW each year until 2050, at which time powerplant capacity is at 975 MW. The average annual capacity available through the period of analysis is 987 MW.

The annual energy available averages 4527 GWh in the early years through 2016, and 4209 GWh throughout the period of analysis. Annual energy production in 2050 is 3875 GWh.

3.10.2.3.2.2 Hoover Dam

The average capacity available from Hoover Powerplant is shown in Table 7 of Attachment P. The powerplant capacity begins at 2061 MW in 2002 and is reduced to 1971 MW in 2016. The capacity either increases or decreases in consecutive years by up to 44 MW, with the capacity in 2050 being 1865 MW. The average capacity available throughout the period of analysis is 1935 MW.

The average annual energy available is 4701 GWh through 2016, and 4087 GWh throughout the period of analysis. Annual energy production in 2050 is 3496 GWh.

3.10.2.3.3 Flood Control Alternative

3.10.2.3.3.1 Glen Canyon Dam

The average capacity and energy available from Glen Canyon Powerplant under the Flood Control Alternative are shown in Table 5 of Attachment P. The powerplant capacity begins at 1020 MW in 2002 and is reduced to 962 MW in 2016. The decline continues to 975 MW in the year 2050. From 2002 through 2016, the greatest annual decrease in capacity is 12 MW. This reduction represents less than a one percent average decline in powerplant capacity per year through 2016. The capacity either increases or decreases in consecutive years through the remainder of the period of analysis. Capacity changes from the period 2016 through 2050 are predominantly in the two to six MW range each year, either increasing or decreasing.

Annual energy production from Glen Canyon averages 4532 GWh in the early years through 2016 and averages 4223 GWh throughout the period of analysis. Annual energy production in 2050 is 3875 GWh.

3.10.2.3.3.2 Hoover Dam

The annual capacity and energy available from Hoover Powerplant under the Flood Control Alternative are shown in Table 7 of Attachment P. The powerplant capacity begins at 2062 MW in 2002 and is reduced to 2033 MW in 2016. Powerplant capacity continues on a declining trend, until the capacity reaches 1865 MW in 2050. The greatest declines in the period from 2002 through 2016 are five and 13 MW, with the annual decline in capacity being predominantly one to two MW.

Under the Flood Control Alternative, the annual energy available from Hoover Powerplant averages 4686 GWh during the period 2002 through 2016. The average for the period from 2017 through 2050 is 3908 GWh. The average for the entire study period is 4146 GWh.

3.10.2.3.4 Six States Alternative

3.10.2.3.4.1 Glen Canyon Dam

The capacity available from Glen Canyon Powerplant under the Six States Alternative begins at 1014 MW in 2002 and decreases to 960 MW in 2016. The capacity then follows a generally increasing trend through 2043, after which annual reductions lead to a capacity of 975 MW in 2050. The capacity available averages 980 MW throughout the period of analysis. Annual changes of between two and five MW are predominant in the Six States Alternative.

The annual energy production averages 4527 GWh through 2016, and 4211 GWh throughout the period of analysis. Annual energy reductions throughout the period of analysis are predominantly less than 50 GWh.

3.10.2.3.4.2 Hoover Dam

The capacity available from Hoover Powerplant under the Six States Alternative begins at 2061 MW in 2002 and decreases to 2005 MW in 2016. The capacity then follows a decreasing trend until the output reaches 1865 MW in 2050. The predominant annual capacity reductions throughout the study period are less than 10 MW.

The average annual energy production is 4698 GWh through 2016. The average annual energy production throughout the period of analysis is 4091 GWh. Annual energy production reductions in successive years are predominantly less than 50 GWh.

3.10.2.3.5 California Alternative

3.10.2.3.5.1 Glen Canyon Dam

The capacity available from Glen Canyon Powerplant under the California Alternative begins at 1007 MW in year 2002, and is reduced to 958 MW in 2016. The capacity follows a generally increasing trend from 2016 through the end of the period of analysis. In 2050, the capacity is 975 MW. Annual changes in plant capacity are generally between two and five megawatts.

Energy production at Glen Canyon averages 4516 GWh through 2016, and 4193 GWh throughout the entire period of analysis. Annual changes in energy production are generally less than 30 GWh.

3.10.2.3.5.2 Hoover Dam

The capacity available from Hoover Powerplant under the California Alternative begins at 2061 MW in year 2002, and is reduced to 1907 MW in 2016. The capacity follows a generally downward trend from 2016 through the end of the period of analysis. In 2050, the capacity of Hoover is 1867 MW. Annual changes in plant capacity are generally less than 10 megawatts.

Annual energy production at Hoover averages 4709 GWh through 2016, and 4016 GWh throughout the period of analysis. Annual changes in energy production are predominantly less than 20 GWh.

3.10.2.3.6 Shortage Protection Alternative

3.10.2.3.6.1 Glen Canyon Dam

The capacity available from Glen Canyon Powerplant under the Shortage Protection Alternative begins at 1009 MW in 2002 and is reduced to 958 MW in the year 2016. The capacity generally increases to 988 MW in the early 2040s, then is reduced to 975 MW in the year 2050. Annual capacity variations are generally from two to six megawatts.

Energy production averages 4518 GWh through 2016, and 4193 GWh throughout the entire study period. Annual energy production variations are generally less than 30 GWh.

3.10.2.3.6.2 Hoover Dam

The capacity available from Hoover Powerplant under the Shortage Protection Alternative begins at 2061 MW in 2002 and is reduced to 1904 MW in 2016. The capacity follows a generally decreasing trend from 2016 through 2050, when the capacity reaches 1865 MW. Annual capacity reductions are predominantly in the two to five megawatt range.

Annual energy production averages 4733 GWh from the beginning of the period of analysis to 2016, and 4047 GWh throughout the entire period of analysis. Annual variation throughout the period of analysis is generally less than 100 GWh.

3.10.2.4 COMPARISON OF ALTERNATIVES

As discussed above, the amounts of capacity and energy available as a result of each alternative operating strategy vary on an annual basis. The important measurement of the effects of each alternative is their comparison with the baseline conditions. As indicated, the resources available from Glen Canyon and Hoover powerplants can be expected to be reduced over time, due primarily to increased depletions in the Upper Basin states. This effect is included in model runs for baseline conditions.

Table 3.10-1 summarizes the differences between hydropower capacity and energy generation under each alternative and under baseline conditions. Values under the Flood Control Alternative are typically slightly greater than under baseline conditions. Values under the California and Shortage Protection Alternatives are the furthest from baseline conditions, while values under the Six States and Basin States alternatives are closer to baseline conditions.

The capacity and energy differences (reductions) between each alternative and baseline conditions would be replaced by power available from the market. The greatest single-year difference in energy generation at Glen Canyon Powerplant under any of the alternatives as compared to baseline conditions is 102 GWh, under the California and Shortage Protection Alternatives (see Table 6 of Attachment P) or about 2.5 percent of the modeled average annual generation of Glen Canyon. The effects of interim surplus alternatives are greater at Hoover Powerplant. The greatest single-year difference in annual energy generation under any of the alternatives as compared to baseline conditions is 328 GWh under the California Alternative (see Table 8 of Attachment P), or about eight percent of the modeled average annual energy generation. The average annual generation during the period of analysis under the Preferred (Basin States) Alternative is 0.8 percent (0.3 percent at Glen Canyon and 1.3 percent at Hoover) less than under baseline conditions. The quantities of capacity needed to replace reductions, while not significant when compared to the total capacity installed in the three WSCC regions, may be significant to the entity losing the capacity.

Table 3.10-1
Hydropower Capacity and Energy – Comparison of Alternatives to Baseline Conditions[1]
(Difference between baseline conditions and each alternative[2])

Alternative	2002 – 2016 Average Annual		2017 – 2050 Average Annual		2002 – 2050 Average Annual	
	Capacity (MW)	Energy (GWh)	Capacity (MW)	Energy (GWh)	Capacity (MW)	Energy (GWh)
Glen Canyon Powerplant						
Basin States Alternative	-10	-5	-1	-16	-4	-13
Flood Control Alternative	0	0	0	1	0	1
Six States Alternative	-10	-5	-1	-15	-4	-12
California Alternative	-21	-16	-1	-35	-8	-30
Shortage Protection Alternative	-21	-14	-1	-36	-7	-29
Hoover Powerplant						
Basin States Alternative	-14	15	-14	-87	-14	-56
Flood Control Alternative	1	0	1	5	1	3
Six States Alternative	-11	13	-12	-80	-12	-51
California Alternative	-47	24	-23	-193	-30	-127
Shortage Protection Alternative	-45	20	-20	-147	-28	-96
Total						
Basin States Alternative	-24	10	-15	-103	-18	-69
Flood Control Alternative	1	0	1	6	1	4
Six States Alternative	-21	8	-13	-95	-16	-63
California Alternative	-68	8	-24	-228	-38	-157
Shortage Protection Alternative	-66	6	-21	-183	-35	-125

[1] Appendix P, Tables 8 and 10 compare each alternative to baseline conditions.

[2] Positive (negative) value indicates that cost is higher (lower) under the alternative.

At Glen Canyon, the greatest single-year difference in capacity compared to baseline conditions is 36 MW under the Shortage Protection Alternative (see Table 6 of Attachment P). This amount represents a decrease of 3.5 percent from baseline conditions and approximately 0.3 percent of the installed capacity in the Rocky Mountain Area. At Hoover, the greatest single-year difference in capacity compared to baseline conditions is 137 MW under the California Alternative (see Table 8 of Attachment P). This amount represents a decrease of 6.7 percent from baseline conditions and about 0.2 percent of the installed capacity in the three-state marketing area for Hoover.

Additional water releases resulting from four of the five alternatives (all but the Flood Control Alternative) under consideration will increase the energy available from the powerplants during the first two to seven years of the interim period. This can be expected to reduce energy purchases by the customers from alternate, higher priced resources. Future reductions in power production can be expected to necessitate increased purchases of capacity to meet peak loads and reserves. Purchases of replacement power by power customers would result in changes in costs and increased exposure to market volatility.

3.10.3 SOUTHERN NEVADA WATER SYSTEM LAKE MEAD INTAKE ENERGY REQUIREMENTS

This section discusses potential increases in operating costs of the SNWS Lake Mead intakes that could occur as a result of implementation of the interim surplus criteria alternatives. Increased pumping costs could occur if the alternatives cause lower Lake Mead water surface elevations than baseline conditions.

3.10.3.1 METHODOLOGY

River system modeling, described in detail in Section 3.3, provided the average monthly elevation of Lake Mead for each year during the study period for baseline conditions and each of the alternatives. These elevations are shown in Table 2 of Attachment P. Increases or decreases in net effective pumping head correspond to decreases or increases in Lake Mead Surface elevations. The net effective pumping head differences between the baseline and the alternative strategies are also shown in Table 2 of Attachment P. Using an estimate prepared by SNWA (Johnson, 2000) for incremental pumping costs of $28,000 per year associated with each foot of increased pumping head, the increased cost of each alternative is shown in Table 2 of Attachment P.

3.10.3.2 AFFECTED ENVIRONMENT

The State of Nevada, through the SNWA, diverts most of its allocation of Colorado River water from Lake Mead through the SNWS into the Las Vegas Valley and adjacent areas. The power-consuming features of this system are the pumping plants from Lake Mead to the water treatment facility. The energy required to provide this lift is a function of the net difference in elevation between the Lake Mead water surface and the water treatment facility. Any increase in the net effective pumping head would increase the amount of energy required to pump each acre-foot of water from Lake Mead. The net effective pumping head will increase as the Lake Mead elevation falls. Water users in Clark County, Nevada and possibly others would absorb increased costs associated with water supply.

3.10.3.3 ENVIRONMENTAL CONSEQUENCES

The difference in net effective pumping head between each alternative and baseline projections is used to determine the effects of each alternative on pumping cost. The following analysis uses the estimate of $28,000 per year per foot increase in net effective pumping head furnished in the aforementioned letter. Baseline pumping costs were not calculated.

3.10.3.3.1 Baseline Conditions and Alternatives

Under baseline conditions, the average elevation of Lake Mead declines from 2002 through 2050. These results indicate that under baseline conditions and each of the alternatives, SNWA can expect pumping costs to increase due to the increase in net effective pumping head. Table 3.10-2 summarizes potential differences between pumping costs under the alternatives and baseline conditions.

Table 3.10-2
Southern Nevada Water System Lake Mead Intake Energy Requirements
Average Annual Power Cost – Comparison of Alternatives to Baseline Conditions[1]
(Differences between baseline conditions and each alternative)

Alternative	2002-2016	2017 - 2050	2002 - 2050
Basin States Alternative	$ 229,395	$ 94,352	$ 135,691
Flood Control Alternative	$ -32,685	$ -21,025	$ -24,594
Six States Alternative	$ 214,779	$ 88,027	$ 126,829
California Alternative	$ 544,843	$ 205,652	$ 309,486
Shortage Protection Alternative	$ 532,635	$ 170,314	$ 281,229

[1] $28,000/per year per foot increase in net effective pumping head at year 2000 price level
[2] Positive (negative) value indicates that cost is higher (lower) under the alternative.

The Flood Control Alternative, when compared to baseline conditions, results in reduced costs for SNWA to pump Colorado River water into its system. The Basin States and Six States alternatives result in average pumping cost increases of about $130,000 per year over the entire period of analysis. The California Alternative and the Shortage Protection Alternative result in average pumping cost increases of about $300,000 per year over the entire period of analysis.

3.10.4 INTAKE ENERGY REQUIREMENTS AT LAKE POWELL

This section discusses potential changes in pumping costs for two entities that pump water from Lake Powell: the Navajo Generating Station which obtains cooling water from Lake Powell, and the City of Page which obtains municipal water from Lake Powell. Incremental differences in pumping costs are associated with differences in modeled average Lake Powell surface elevations between baseline conditions and alternatives.

3.10.4.1 METHODOLOGY

River system modeling, described in detail in Section 3.3, provided the average elevation of Lake Powell for each year during the study period for baseline conditions and for each of the alternatives. Increases or decreases in net effective pumping head correspond with decreases or increases in Lake Powell surface elevations. Lake Powell elevations and the net effective pumping head differences between baseline conditions and the alternatives are shown in Table 1 of Attachment P. Estimates of the differences in pumping costs were calculated using these changes in pumping head, as well as estimates of annual water use, unit energy costs and pump efficiency.

The formula for calculating energy requirements (E) as a function of pump lift (H) is:

$$E = V * 1.024 * (H/e)$$

Where V is the volume of water pumped and e is pump efficiency.

3.10.4.2 AFFECTED ENVIRONMENT

The Navajo Generating Station is a 2250 MW, coal-powered plant jointly owned by Reclamation, Salt River Project, Los Angeles Department of Water and Power, Arizona Public Service Company, Nevada Power and Tucson Electric Power. The Salt River Project (SRP) operates the plant. The SRP projects that water use will be approximately 29,000 afy in the future. Power for the intake pumps is obtained from auxiliary power units at the Generating Station at a cost of $0.0104 per kWh. Pump efficiency is estimated by SRP at 75 percent. (Weeks, 2000)

The City of Page provides municipal water to approximately 7800 residents from Lake Powell. The intake pump station is operated by Reclamation using power produced at the Glen Canyon Power Plant. Municipal water use in Page is dominated by residential use with substantial residential landscape irrigation. A negligible amount of treated water is delivered by the city to Reclamation for use at the dam. Presuming 275 gallons per day per resident, annual use would be approximately 2400 afy. An overall efficiency of 75 percent for the pump station was used as a reasonable estimate. A cost of $0.03 per kWh was estimated as the cost of the electricity.

3.10.4.3 ENVIRONMENTAL CONSEQUENCES

The difference in net effective pumping head between each alternative and baseline projections was used to determine the effects of each alternative on pumping cost. Baseline pumping costs were not calculated.

Under baseline projections, the average elevation of Lake Powell declines from elevation 3685 feet msl in year 2002 to elevation 3661 feet msl in year 2050 (Appendix P, Table 1). Table 3.10-3 compares the annual power costs of each alternative to baseline conditions.

As Lake Powell water elevations are within hundredths of a foot for baseline conditions and for the Flood Control Alternative, no change in pumping costs would occur. For all other alternatives, Lake Powell water elevations average less than under baseline conditions. Average pumping costs would be higher for both the Navajo Generating Station (average increase of $808 per year over the period of analysis for the Basin States Alternative) and for the Reclamation-operated raw water intake serving the City of Page. (Average increase of $193 per year over the period of analysis for the Basin States Alternative).

Table 3.10-3
Intake Energy Requirements at Lake Powell
Average Annual Power Cost – Comparison of Alternatives to Baseline Conditions (Difference between baseline conditions and each alternative)

Alternative	2002–2016	2017–2050	2002–2050
Navajo Generating Station Intake Energy Requirements[1]			
Basin States	$ 2,216	$ 186	$ 808
Flood Control	0	0	0
Six States	2,129	172	771
California	4,651	303	1,634
Shortage Protection	4,660	312	1,643
City of Page Municipal Water Supply[2]			
Basin States	$ 529	$ 44	$ 193
Flood Control	0	0	0
Six States	508	41	184
California	1,110	72	390
Shortage Protection	1,112	74	392

[1] E(kWh) = 1.024 * 29,000 * (H/0.75). Cost = E(kWh) * $ 0.0104
[2] E(kWh) = 1.024 * 2,400 * (H/0.75). Cost = E(kWh) * $ 0.03
Estimates are annual averages for the indicated time periods.