3.10 ENERGY RESOURCES

3.10.1 INTRODUCTION

The analyses in this section consider two specific issues associated with energy resources. The issues considered are potential changes in hydropower production from Hoover Dam and Glen Canyon Dam and potential increases in energy requirements of Southern Nevada Water System (SNWS) Lake Mead intake.

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.

3.10.2.1 METHODOLOGY

In order to determine the effects of the interim surplus criteria alternatives, the information produced from the hydrologic 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 to determine the effects of the alternatives on power generation are:

- Average Lake Powell Elevation
- Average Glen Canyon Powerplant Energy Output
- Average Lake Mead Elevation
- Average Hoover Powerplant Energy Output
- Average Lake Mohave Elevation (constant at an elevation of 647 feet msl throughout study period)

These quantities, derived from the model runs, are shown in Tables 1 through 4, in Attachment N. In addition, powerplant capability curves for Glen Canyon and Hoover Powerplants showing maximum 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 5 and 6 in Attachment N.

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 energy production capacity and energy production, on an annual basis, between the baseline strategy 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. Capacity and energy quantities for the baseline and the alternatives are shown in Tables 7 and 9 in Attachment N. Comparisons of the annual power production associated with each alternative with the annual power production of the baseline projections are shown in Tables 8 and 10 in Attachment N.

3.10.2.2 AFFECTED ENVIRONMENT

The energy resources that could be affected by changes in Colorado River operation are Glen Canyon and Hoover Powerplant electrical energy 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 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 on a hydroelectric system 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 behind a dam and in the tailbay below the dam. The head determines the maximum capacity, measured in MW. However, that is available from the powerplant. The nameplate capacity of Glen Canyon Powerplant is 1,296 MW. However, the maximum operating capacity of Glen Canyon Powerplant generators is approximately 1,200 MW due to turbine restrictions (Western, 1998). The maximum operating capacity of Hoover Powerplant is 2,074 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 megawatt-hours (MWh). The net energy generated during fiscal year 1998 from Glen Canyon Powerplant and Hoover Powerplant was 6,626,000 MWh and 5,845,000 MWh, respectively (Western, 1998).

The turbines at a powerplant are designed to produce maximum horsepower output at a rated head. At rated head, the turbines are the most efficient when operated near full gate opening. At rated 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 rated 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. Therefore, the states affected by the alternative operating strategies 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 States 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 capabilities of these WSCC areas are:

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

Of the total generating capability of these three areas of WSCC as shown above (WSCC, 1999), Glen Canyon and Hoover powerplants contribute approximately 3.6 percent of the total. The maximum capacity available from Glen Canyon Powerplant at 3700 feet in elevation is approximately 1,200 MW. The total operable capacity from Hoover and Glen Canyon powerplants is then 2,074 MW and 1,048 MW, respectively, for a total of 3,122 MW. This represents about 3.6 percent of the total installed generation in the market served by the two resources.

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 changed power production probabilities under the alternatives are compared to baseline projections to determine the incremental effects of each alternative, using average reservoir levels and downstream releases developed through system modeling.

3.10.2.3.1 Baseline Conditions

Reductions in either capacity or energy, or both, from Glen Canyon and Hoover powerplants under baseline conditions and the alternatives would ultimately need to be replaced by other types of generation. 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 the capacity loss is intermittent throughout the study period, purchases from the short-term market can 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 can be expected. If energy loss is intermittent throughout the study period, replacement from the short-term market can be anticipated under baseline conditions.

3.10.2.3.1.1 Glen Canyon Dam

The annual capacity and energy available from Glen Canyon Dam under baseline projections are shown in Table 7 in Attachment N. The powerplant capacity begins at 1,020 MW for year 2000, and is reduced annually because of reductions in lake elevation to 973 MW in 2015, and to 947 in the year 2050. From 2000 through 2015, the greatest annual decrease in capacity is 6 MW the first year. The annual reduction is from 2 to 4 MW, representing less than a 1 percent decline in capacity from the powerplant per year. The output remains constant at 950 MW from 2031 through 2046, and then falls to 947 MW in the year 2050.

Under baseline projections, the energy available from Glen Canyon Dam averages 4,732 GWh from 2000 through 2015, and 4,238 GWh through the rest of the study period. Annual reductions in energy production range from 10 GWh to 213 GWh through 2015, with the predominant changes less than 60 GWh. Annual reductions in energy from 2015 through 2050 range from 10 GWh to 40 GWh with the predominant changes less than 30 GWh.

3.10.2.3.1.2 Hoover Dam

The annual capacity and energy available from Hoover Powerplant under baseline projections are shown in Table 9 of Attachment N. The powerplant capacity begins at 2074 MW for year 2000, and is reduced to 2063 MW in 2015 because of reductions in lake elevation, and to 1,901 MW in the year 2050. From 2000 through 2015, the greatest annual decrease in capacity is 4 MW. This reduction represents less than a 1 percent decline in capacity from the powerplant per year through 2015. From 2015 through 2033, annual reductions of from 2 to 5 MW are experienced. From 2034 through 2050, annual reductions range predominantly from 1 to 5 MW.

The energy available from Hoover Powerplant averages 4,979 GWh from 2000 through 2015, and 4,275 GWh through the rest of the study period. Annual reductions in energy production range between 10 GWh and 300 GWh through 2015, with the predominant changes being less than 100 GWh. Annual reductions in energy production range between 10 GWh and 300 GWh through 2015, with the predominant changes being less than 100 GWh. Annual reductions in energy from 2015 through 2050 range between 10 GWh and 100 GWh with the predominant changes being less than 60 GWh.

3.10.2.3.1.3 Combined Capacity Reduction Under Baseline Conditions

The combined capacity reduction from Glen Canyon and Hoover Powerplants through 2015 is 58 MW under baseline projections. The combined energy production in 2015 is 1,237 GWh less than year 2000 energy production. In 2050, the capacity reduction is 268 MW from year 2000 levels, and the energy available is reduced 2,700 GWh from year 2000 levels. Under baseline projections, power customers can expect a reduction in resource from present levels in the future. Because of the gradual withdrawal over time, the deficit is expected to be replaced by short-term purchases.

3.10.2.3.2 Flood Control Alternative

3.10.2.3.2.1 Glen Canyon Dam

The average capacity and energy available from Glen Canyon Powerplant under the Flood Control alternative are shown in Table 7 of Attachment N. The powerplant capacity begins at 1,020 MW for year 2000 and is reduced to 973 MW in 2015 and to 947 MW in the year 2050. From 2000 through 2015, the greatest annual decrease in capacity is 6 MW the first year. This reduction represents less than a 1 percent decline in powerplant capacity per year through 2015. The capacity continues to decline from 2016 through 2035 and then remains close to 950 MW through the remainder of the study period. Capacity reductions from the period 2000 through 2050 are predominantly in the 2 to 4 MW range each year.

3.10.2.3.2.2 Hoover Dam

The annual capacity and energy available from Hoover Powerplant under Flood Control Alternative conditions are shown in Table 9 of Attachment N. The powerplant capacity begins in 2000 at 2,074 MW and is reduced to 2,065 MW by 2015. Powerplant capacity continues to decline until in 2050, the capacity reaches 1,903 MW. The greatest decline in the period 2000 through 2015 is 4 MW, with the annual decline in capacity being predominantly 1 to 2 MW.

Under Flood Control Alternative conditions, the energy available from Hoover Powerplant averages 4,975 GWh during the period 2000 through 2015. The average for the period 2016 through 2050 is 4,289 GWh. The average for the entire study period is 4,504 GWh.

A comparison of the Flood Control Alternative with the baseline projections is shown in Table 10 of Attachment N. The Flood Control Alternative results in approximately the same capacity available for the period 2000 through 2015 as baseline conditions. However, the capacity available is greater for the period 2016 through 2050. The amount of capacity above that available in the baseline projections each year for the period 2016 through 2050 is predominantly 4 MW. The energy available from Hoover averages 4 GWh per year less than the baseline projections during the period 2000 through 2015 and 13 GWh more for the period 2016 through 2050. Energy available throughout the study period averages 8 GWh more than in the baseline projections.

3.10.2.3.3 Six States Alternative

3.10.2.3.3.1 Glen Canyon Dam

A comparison with baseline conditions shows reductions in capacity of 15 MW greater in 2015 for the Six States Alternative. This alternative yields greater energy production between 2000 and 2010, with the average energy production from 2000 through 2015 being 5 GWh per year greater than the baseline conditions. For the rest of the study period, the capacity available each year is reduced from 2 to 13 MW greater than with baseline conditions, with the average during the period 2016 through 2050 being 5 MW less than baseline conditions. Energy production during the period 2016 through 2050 is an average 27 GWh per year less than baseline conditions.

3.10.2.3.3.2 Hoover Dam

A comparison with baseline conditions shows reductions in capacity of 21 MW greater in 2015 for the Six States Alternative. This alternative yields greater energy production between 2000 and 2011, with the average energy production from 2000 through 2015 being 29 GWh per year greater than baseline conditions. For the rest of the study period, the capacity available each year is reduced up to 60 MW as compared with baseline conditions, but with the same amount of capacity as baseline conditions in the last eight years of the study period. The average capacity reduction during the period 2016 through 2050 is 15 megawatts less than baseline conditions.

Energy production during the period 2016 through 2050 is an average 77 GWh less than baseline conditions.

The Six States Alternative compared with baseline conditions indicates an increased potential for some additional reductions in capacity and energy over the study period, but on average, these reductions are relatively small when compared to the total power production of the two resources.

3.10.2.3.4 California Alternative

3.10.2.3.4.1 Glen Canyon Dam

A comparison of the California Alternative with baseline conditions is shown on Table 8 of Attachment N. This comparison shows reductions in capacity of 23 MW greater than baseline projections in 2015. The California Alternative yields greater energy production between 2000 and 2010, with the average energy production from 2000 through 2015 being 7 GWh per year greater than baseline conditions. For the rest of the study period, the capacity available each year is reduced from 2 to 21 MW from baseline conditions, with the average during the period 2016 through 2050 being 8 MW less than baseline conditions. Energy production during the period 2016 through 2050 is an average 43 GWh less than baseline conditions.

3.10.2.3.4.2 Hoover Dam

A comparison of the California Alternative with baseline conditions is shown in Table 10 of Attachment N. This comparison shows reductions in capacity of 36 MW greater than baseline conditions in 2015 under the California Alternative. This alternative yields greater energy production between 2000 and 2012, with the average energy production from 2000 through 2015 being 51 GWh greater than baseline conditions. For the rest of the study period, the capacity available each year is reduced up to 65 MW from the baseline conditions. The average during the period 2016 through 2050 is 27 MW less than baseline conditions. Energy production during the period 2016 through 2050 is an average of 126 GWh per year less than baseline conditions.

3.10.2.3.5 Shortage Protection Alternative

3.10.2.3.5.1 Glen Canyon Dam

A comparison with baseline conditions shows reductions in capacity of 25 MW greater in 2015 for the Shortage Protection Alternative. This alternative yields greater energy production between 2000 and 2009, with the average energy production from 2000 through 2015 being 6 GWh per year greater than baseline conditions. For the rest of the study period, the capacity available each year is reduced from 2 to 25 MW from baseline conditions, with the average during the period 2016 through 2050 being 9 MW less than baseline conditions. Energy production during the period 2016 through 2050 is an average 47 GWh per year less than baseline conditions.

3.10.2.3.5.2 Hoover Dam

A comparison with baseline conditions shows reductions in capacity of 40 MW greater in 2015 for the Shortage Protection Alternative. This alternative yields greater energy production between 2000 and 2011, with the average energy production from 2000 through 2015 being 60 GWh per year greater than baseline conditions. For the rest of the study period, the capacity available each year is reduced up to 67 MW from baseline conditions. The average capacity reduction during the period 2016 through 2050 is 30 MW less than baseline conditions. Energy production during the period 2016 through 2050 is an average 144 GWh per year less than baseline conditions.

Modeling of the Shortage Protection Alternative indicates an increased potential for greater reductions in capacity and energy over the study period than baseline conditions and the other alternatives. There are, however, greater amounts of energy in the early years than other alternatives when compared with the baseline projections.

3.10.2.3.6 Comparison of Alternatives

The capacity and energy reductions associated with each alternative, when compared with baseline conditions, should be available from the market. The greatest annual reduction in energy generation at Glen Canyon Powerplant from baseline projections is about 3 percent of the average throughout the study period. At Hoover Powerplant, the greatest reduction represents 7 percent. The quantities of capacity needed to replace the reductions are not significant when compared to the total capacity installed in the three WSCC regions. Compared with the Six States Alternative, the California Alternative has a probability of allowing for more energy production in the early years with increased potential for decreased capacity through much of the study period. The Shortage Protection Alternative provides for greater amounts of energy than either of the other two alternatives in the early years, but results in an increased potential for greater energy reductions during the middle years of the study period. In general, power customers could expect little change in electrical energy costs as a result of the interim surplus criteria alternatives under consideration.

3.10.3 SOUTHERN NEVADA WATER SYSTEM LAKE MEAD INTAKE ENERGY REQUIREMENTS

This section discusses potential increases in 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

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 evaluations are shown in Table 11 of Attachment N. Increases or decreases in net effective pumping head correspond with decreases or increases in Lake Mead Surface elevations. The net effective pumping head difference between the baseline and the alternative strategies are shown in Table 11 of Attachment N. Using an estimate for incremental pumping costs of $28,000 per year associated with each foot of increased pumping head prepared by SNWA (Johnson, 2000), the increased cost of each alternative is shown in Table 11 of Attachment N. The positive numbers in the columns correspond to an increase in costs, while a negative number corresponds to a decrease in costs.

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 will 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

Under baseline projections, the average elevation of Lake Mead declines steadily from the year 2000 through 2050. These results indicate that SNWA can expect pumping cost increases each year due to the increase in net effective pumping head.

3.10.3.3.2 Flood Control Alternative

Under the Flood Control Alternative, average Lake Mead elevations are from one to two feet higher throughout the study period than under baseline projections. This results in an average annual reduction in pumping costs when compared with baseline projections of $34,909 for the period 2000 through 2015 and of $47,828 through 2050.

3.10.3.3.3 Six States Alternative

Under the Six States Alternative, average Lake Mead elevations are lower than baseline projections. The lower elevations result in higher pumping costs. From 2000 through 2015, pumping cost increases when compared with baseline projections average $164,334 per year. From 2016 through 2050, these increases average $134,697 per year. The average cost increase throughout the study period is $143,995 per year. The highest cost increases occur between 2006 and 2044, when the difference between Lake Mead elevations under this alternative and Lake Mead elevation under baseline conditions is greatest.

3.10.3.3.4 California Alternative

Under the California Alternative, average Lake Mead elevations are lower than under baseline projections. When compared with baseline conditions, average costs increase from 2000 through 2015 under the California Alternative is $249,828 per year. The average cost increase between 2016 and 2050 is $216,555 per year. The average annual cost increase throughout the study period is $226,994 per year.

3.10.3.3.5 Shortage Protection Alternative

The Shortage Protection Alternative results in the greatest differences from the baseline strategy. When compared with baseline conditions, the average cost increase for SNWA is $281,973 per year for the period 2000 through 2015. This average cost increase is $240,294 per year for the period 2016 through 2050. The average cost increase through the study period is $253,369 per year using the Shortage Protection Alternative. The greatest cost increases occur prior to 2015 and remain fairly constant through 2041, when the Shortage Protection Alternative produces approximately the same net effective pumping head for SNWA as baseline projections.