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April 30, 2008

Mr. Tyler Carlson  
Regional Manager  
Western Area Power Administration  
P. O. Box 6457  
Phoenix, AZ 85005

Dear Tyler,

The Arizona Power Authority has developed a Study Committee to study the process for the Hoover allocation in the post-2017 timeframe. The Study Committee is composed of Hoover customers, interested parties and the staff of the Arizona Power Authority. The Study Committee would like you to join us at our next scheduled meeting to discuss relevant parameters and facts relating to Hoover generation in the post-2017 timeframe. The time and place of our next scheduled meeting are as follows:

Subject: Study Committee Meeting  
Time: 1:00 p.m.  
Date: May 8, 2008  
Place: Arizona Power Authority Office  
1810 W. Adams Street  
Phoenix, Arizona

We have prepared a list of information requests attached with this letter that we would like to review with you during the May 8th Study Committee meeting. In addition to these questions, you will probably be asked for your thoughts on Hoover A and B capacity and Hoover A, B and C energy and the likelihood of those concepts continuing into the post-2017 allocation process.

| DSW REGIONAL OFFICE<br>OFFICIAL FILE COPY |         |       |
|---|---------|-------|
| Date                                      | Initial | Code  |
| APR 30 2008                               |         |       |
| 4/30/08                                   | JC      | G0000 |
|   |         | G4000 |
|   |         | G6000 |

*response for  
me to take*

We realize that there are certain questions that cannot be answered at this time; however, your candid thoughts on any of the Western allocation process will be very helpful to the Study Committee. Another fundamental question that is on the minds of all Committee members is, "When will Western begin its process for allocating the Hoover power in the post-2017 timeframe?" As we proceed closer to the process, perhaps you can give us additional insight regarding the timing and format for the process.

Thank you very much for helping us with this vitally important matter.

Sincerely,

A handwritten signature in cursive script, appearing to read "J. Mulholland".

Joseph W. Mulholland  
Executive Director

Attachment

cc: Arizona Power Authority Commissioners  
Post-2017 Hoover Allocation Study Committee Members

We have the following information requests relating to capacity generation at the Hoover power plant:

1. Nameplate capacity of Hoover generation.
2. Maximum generation of record during a single hour from the Hoover power plant and associated elevation at Lake Mead at that same time.
3. Recently the staff at Hoover has measured the maximum capacity generation available at various elevations at Lake Mead. Would you provide those results in the form of a table giving elevation of Lake Mead and maximum generation measured during a single hour?
4. In the 1987 allocation process, Western sold to the Hoover customers 1,951 megawatts which is 123 megawatts below the nameplate capacity (2,074 MW?). Could you discuss how Western has used the 123 megawatts of capacity, its availability at head heights below (Lake Mead elevation 1,165) full power generation levels and how this capacity relates to the "65 megawatts" of regulating reserve capacity used by Western for its balancing authority responsibilities?
5. Could you also discuss the regulating reserve capacity requirement under varying operating conditions and how Hoover is used to meet this requirement?
6. In recent years Reclamation has made improvements to the turbines and related equipment associated with several generators at Hoover resulting in increased efficiency. Could you identify those improvements and discuss the effect they would have on generating capacity under varying head heights with special attention to elevation above 1,165 feet at Mead?
7. Are there any permanent or recurring restrictions on the generators at Hoover that would reduce their generating capacity on a prolonged basis?
8. Identify and discuss future upgrades that may impact capacity at the Hoover power plant.

We have the following information requests regarding energy generation at the Hoover power plant:

1. Attached to these questions is a table showing the energy generation from 1953 to 2007 along with the actual water releases at Hoover and the natural flow at Lee's Ferry Crossing. This table was developed by the Authority based upon information from Reclamation. Would you please make any necessary corrections to the table?
2. With the improvements made to the turbines and water flow efficiency at Hoover, are there any studies or information that you can share with us regarding additional energy generation availability?
3. Identify and discuss firming energy provided by Hoover for the DSW Region.
4. Identify and discuss the most recent hydrology study involving the Colorado River and Hoover Dam.

## ARIZONA POWER AUTHORITY

### HISTORICAL AND PROJECTED HYDROLOGY AND GENERATION STATISTICS

| Generation<br>Ten Highest<br>and Lowest | Year | Boulder Canyon Project<br>Operating Year Statistics |                     |            | (CY)                                       | APA<br>Generation<br>(GWh) |
|---|------|---|---------------------|------------|--|----------------------------|
|   |      | Releases<br>(KAF)                                   | Generation<br>(GWh) | gwh<br>kaf | Natural<br>Flow At<br>Lee's Ferry<br>(KAF) |                            |
|   |      |   |                     |            |  |                            |
|   | 1953 | 8,048   | 4,670               | 0.580      | 11,165                                     | 922                        |
|   | 1954 | 10,564  | 4,022               | 0.381      | 8,496                                      | 1108                       |
| 7                                       | 1955 | 8,111   | 2,967               | 0.368      | 9,414                                      | 848                        |
| 1                                       | 1956 | 7,852   | 2,648               | 0.337      | 11,427                                     | 724                        |
|   | 1957 | 9,309   | 3,594               | 0.386      | 21,501                                     | 687                        |
|   | 1958 | 11,865  | 5,087               | 0.429      | 15,863                                     | 963                        |
|   | 1959 | 9,277   | 3,814               | 0.411      | 9,598                                      | 909                        |
|   | 1960 | 8,951   | 3,664               | 0.409      | 11,524                                     | 782                        |
|   | 1961 | 8,543   | 3,367               | 0.394      | 10,010                                     | 951                        |
|   | 1962 | 8,570   | 3,549               | 0.414      | 17,378                                     | 808                        |
|   | 1963 | 8,489   | 3,354               | 0.395      | 8,841                                      | 715                        |
| 4                                       | 1964 | 7,252   | 2,882               | 0.397      | 10,864                                     | 637                        |
| 2                                       | 1965 | 7,749   | 2,669               | 0.344      | 19,875                                     | 638                        |
| 3                                       | 1966 | 7,736   | 2,868               | 0.371      | 10,680                                     | 645                        |
| 6                                       | 1967 | 7,807   | 2,924               | 0.375      | 11,671                                     | 663                        |
| 5                                       | 1968 | 7,794   | 2,914               | 0.374      | 13,740                                     | 648                        |
| 8                                       | 1969 | 7,848   | 3,016               | 0.384      | 15,272                                     | 651                        |
| 9                                       | 1970 | 7,980   | 3,184               | 0.399      | 15,344                                     | 654                        |
| 10                                      | 1971 | 8,120   | 3,197               | 0.394      | 15,456                                     | 662                        |
|   | 1972 | 8,055   | 3,251               | 0.404      | 13,193                                     | 685                        |
|   | 1973 | 8,258   | 3,417               | 0.414      | 18,632                                     | 650                        |
|   | 1974 | 8,688   | 3,553               | 0.409      | 13,365                                     | 634                        |
|   | 1975 | 8,323   | 3,450               | 0.415      | 17,046                                     | 629                        |
|   | 1976 | 7,883   | 3,511               | 0.445      | 11,284                                     | 679                        |
|   | 1977 | 7,828   | 3,570               | 0.456      | 5,512                                      | 706                        |
|   | 1978 | 7,433   | 3,417               | 0.460      | 15,371                                     | 603                        |
|   | 1979 | 7,684   | 3,594               | 0.468      | 17,938                                     | 703                        |
| 9                                       | 1980 | 11,021  | 5,106               | 0.463      | 17,878                                     | 703                        |
|   | 1981 | 8,269   | 3,648               | 0.441      | 8,986                                      | 707                        |
|   | 1982 | 7,435   | 3,265               | 0.439      | 17,547                                     | 617                        |
| 3                                       | 1983 | 16,934  | 8,224               | 0.486      | 24,456                                     | 654                        |
| 1                                       | 1984 | 21,377  | 10,348              | 0.484      | 25,473                                     | 709                        |
| 4                                       | 1985 | 17,224  | 8,153               | 0.473      | 20,987                                     | 702                        |
| 2                                       | 1986 | 17,530  | 8,284               | 0.473      | 23,200                                     | 661                        |
| 8                                       | 1987 | 11,322  | 5,250               | 0.464      | 15,677                                     | 801                        |
|   | 1988 | 9,410   | 4,507               | 0.479      | 11,473                                     | 990                        |
|   | 1989 | 9,150   | 4,348               | 0.475      | 10,046                                     | 824                        |
|   | 1990 | 9,190   | 4,287               | 0.486      | 9,584                                      | 824                        |
|   | 1991 | 8,938   | 4,013               | 0.449      | 12,263                                     | 752                        |
|   | 1992 | 7,814   | 3,595               | 0.460      | 10,904                                     | 701                        |
|   | 1993 | 7,422   | 3,452               | 0.465      | 18,436                                     | 634                        |
|   | 1994 | 9,338   | 4,310               | 0.462      | 10,623                                     | 846                        |
|   | 1995 | 8,529   | 3,856               | 0.452      | 20,453                                     | 777                        |
|   | 1996 | 9,966   | 4,659               | 0.467      | 14,600                                     | 1005                       |
| 6                                       | 1997 | 11,627  | 5,568               | 0.479      | 21,778                                     | 1584                       |
| 5                                       | 1998 | 12,738  | 6,202               | 0.487      | 16,826                                     | 1413                       |
| 7                                       | 1999 | 11,008  | 5,329               | 0.484      | 16,241                                     | 1337                       |
| 10                                      | 2000 | 10,674  | 5,103               | 0.478      | 10,886                                     | 1267                       |
|   | 2001 | 10,192  | 4,746               | 0.466      | 10,805                                     | 1145                       |
|   | 2002 | 10,434  | 4,683               | 0.466      | 6,243                                      | 1089                       |
| 2004 on down                            | 2003 | 9,369   | 4,034               | 0.449      | 10,569                                     | 795                        |
| Actuals based                           | 2004 | 9,624   | 4,021               | 0.431      | 9,938                                      | 776                        |
| on PO&M59                               | 2005 | 7,935   | 3,255               | 0.418      | 16,901                                     | 646                        |
| for OpYr                                | 2006 | 9,399   | 3,852               | 0.410      | 13,587                                     | 759                        |
|   | 2007 | 9,463   | 3,807               | 0.410      | 12,800                                     | 737                        |

## Western Response to Arizona Power Authority Letter dated April 30, 2008:

### Information requests related to capacity generation at the Hoover power plant:

1. Nameplate capacity of Hoover generation.

Response: 2,074 MW

2. Maximum generation of record during a single hour from the Hoover power plant and associated elevation at Lake Mead at that same time.

Response: 1,885 MW @ 1196.7 feet on September 12, 2000 hourly integrated beginning 15:00 ending 16:00.

3. Recently the staff at Hoover has measured the maximum capacity generation available at various elevations at Lake Mead. Would you provide those results in the form of a table giving elevation of Lake Mead and maximum generation measured during a single hour?

Response: See attached table titled "Historical Changes in Hoover Capacity"

4. In the 1987 allocation process, Western sold to the Hoover customers 1,951 megawatts which is 123 megawatts below the nameplate capacity (2,074MW?). Could you discuss how Western has used the 123 megawatts of capacity, its availability at head heights below (Lake Mead elevation 1,165) full power generation levels and how this capacity relates to the "65 megawatts" of regulating reserve capacity used by Western for its balancing authority responsibilities?

Response: When available, capacity above 1,951 MW is used by Western for regulation and reserves to meet Western's requirements. When Lake Mead elevation is below 1,165 ft. Hoover capacity is reduced below 2,074 MW. Therefore in times in which Lake Mead elevation is below 1,165 ft., the 123 MW is not fully available for Western's use. Lake Mead elevation has not exceeded the 1,165 ft. level since 2002. Based on the April 2008 Reclamation 24-month study Lake Mead elevation is not projected to approach the 1,165 ft. level.

5. Could you also discuss the regulating reserve capacity requirement under varying operating conditions and how Hoover is used to meet this requirement?

Response: Western's Regulating Reserve Capacity (Regulation) requirement is autonomous to Hoover operating conditions. If Hoover's available capacity is above 1,951 Western is able to use the capacity above 1,951 for Regulation and reserves. In times in which Hoover's available capacity is below 1,951 Western uses unscheduled Hoover capacity for the regulation and reserves. In the event sufficient capacity is not available from the Federal generators (Hoover, Parker and Davis dams) for

Regulation or reserve requirements, market purchases are made to meet these requirements.

6. In recent years Reclamation has made improvements to the turbines and related equipment associated with several generators at Hoover resulting in increased efficiency. Could you identify those improvements and discuss the effect they would have on generating capacity under varying head heights with special attention to elevation above 1,165 feet at Mead?

Response: The attached table labeled "Hoover Power Plant Capacity Increases Achieved and Future Plan" as supplied by the U.S. Bureau of Reclamation (Reclamation) depicts the recent modifications to Hoover units and the potential capacity increase. The current capacity improvements being conducted at Hoover are only effective at low lake elevations below 1,145 ft., with diminishing returns between 1,145 and 1,165 ft. Additional capacity will not be gained above the 1,165 ft. elevation unless generators are modified or replaced to increase the generator ratings.

7. Are there any permanent or recurring restrictions on the generators at Hoover that would reduce their generating capacity on a prolonged basis?

Response: Outside of Lake Mead elevation and routine/non-routine maintenance, Western does not perceive any permanent or recurring restrictions that would affect Hoover generation capacity for a prolonged basis. As provided by Reclamation in recent meetings, there is concern that the formation of Quagga mussels may affect the penstocks and unit cooling. At this time it is unknown whether the eradication of these would result in any unplanned unit outages or affects on generation capacity for any prolonged period of time.

8. Identify and discuss future upgrades that may impact capacity at the Hoover power plant.

Response: At the Hoover Technical Review Committee meeting in September 2007, Reclamation was authorized to proceed with the study of "wide-head" turbines. Although initially low-head turbines were envisioned, wide-head turbines provide more capacity and greater efficiencies over a wider range of lake elevations. At the January 2008 Hoover Engineering & Operating Committee (E&OC) meeting Reclamation presented "Low Head Turbine Overview" (see attached). At the upcoming Hoover E&OC meeting in May 2008, the status of the wide-head turbine study will be discussed.

Information requests regarding energy generation at the Hoover power plant:

1. Attached to these questions is a table showing the energy generation from 1953 to 2007 along with the actual water releases at Hoover and the natural flow at Lee's Ferry crossing. This table was developed by the Arizona Power Authority based

upon information from Reclamation. Would you please make any necessary corrections to the table?

Response: Western uses Reclamation as the sole source of information of this type. Therefore, Reclamation is the independent source of this data. Upon inquiring with Reclamation regarding the table APA provided, Reclamation was able to provide Western data from 1953 to 2007. See attachment labeled "APA/Reclamation historical data differences table" for any variations.

2. With the improvements made to the turbines and water flow efficiency at Hoover, are there any studies or information that you can share with us regarding additional energy generation availability?

Response: Three improvements have been reviewed at Hoover relative to turbine and water efficiency. 1) Overhaul of the units 2) Stainless Steel Wicket Gates 3) Pressure Release Valves (PRV). Over time wear and tear on the units degrade the efficiency. An overhaul would not only extend the life of the unit, but potentially yield a more productive unit for years to come. New wicket gates and PRV's would help to ensure that required water releases are met by water going through the turbines and producing electricity and not around the unit or through it in some inefficient manner. Once completed it is estimated that these improvements would yield benefits over the next 20+ years. It is estimated that roughly 3,100 Mwh of additional generation would be realized from the combined wicket gate and PRV improvements. See attachment "BOR Responses to APA Question #2" for additional details.

3. Identify and discuss firming energy provided by Hoover for the DSW Region.

Response: Hoover is utilized as an integrated resource within the DSW Region. Due to the fact that the Hoover units are on Automatic Generation Control (AGC) that is responsive to more than Hoover customer demand, there is a continuous deviation of actual Hoover generation and what was delivered to the Hoover customers. Western manages and balances this deviation to zero on an annual basis. Western does not utilize Hoover as a resource of firming energy.

4. Identify and discuss the most recent hydrology study involving the Colorado River and Hoover Dam.

Response: Western relies on Reclamation for all hydrologic studies involving the Colorado River and Hoover Dam. On a monthly basis, Reclamation publishes a 24-month study of hydrology of the Colorado River, which includes Hoover Dam. You may access the April 7, 2008 Reclamation 24-month study at the website indicated below: <http://www.usbr.gov/lc/region/g4000/24mo.pdf>

| Historical Changes In Hoover Capacity | Unit | ORIGINAL | UPRATE | CURRENT | NAMEPLATE | Lake Mead Elevation (feet): | Date Capacity Effective: | 1197       | 1193      | 1172     | 1162      | 1156      | 1148     | 1145      | 1135     | 1129      | 1135      | 1143      | 1147      | 1141      | 1138      |
|---------------------------------------|------|----------|--------|---------|-----------|-----------------------------|--------------------------|------------|-----------|----------|-----------|-----------|----------|-----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|
|                                       |      |          |        |         |           |                             |                          | 11/27/2000 | 4/20/2001 | 4/2/2002 | 6/11/2002 | 9/16/2002 | 5/8/2003 | 6/10/2003 | 5/4/2004 | 6/18/2004 | 1/18/2005 | 2/25/2005 | 3/21/2005 | 4/11/2005 | 4/14/2006 |
| A1                                    | 82.5 | 130      | 130    | 130     | 130       | 130                         | 130                      | 130        | 130       | 130      | 125       | 123       | 121      | 120       | 116      | 114       | 116       | 119       | 120       | 130       | 127       |
| A2                                    | 82.5 | 130      | 130    | 130     | 130       | 130                         | 130                      | 130        | 130       | 128      | 124       | 123       | 120      | 115       | 112      | 111       | 112       | 116       | 115       | 119       | 120       |
| A3                                    | 82.5 | 130      | 130    | 130     | 130       | 130                         | 130                      | 127        | 127       | 120      | 116       | 114       | 111      | 109       | 104      | 104       | 104       | 109       | 110       | 110       | 108       |
| A4                                    | 82.5 | 130      | 130    | 130     | 130       | 130                         | 130                      | 127        | 117       | 117      | 114       | 110       | 109      | 108       | 103      | 100       | 103       | 107       | 108       | 109       | 107       |
| A5                                    | 82.5 | 127      | 127    | 127     | 127       | 127                         | 127                      | 127        | 127       | 123      | 119       | 118       | 118      | 112       | 106      | 105       | 106       | 110       | 112       | 111       | 107       |
| A6                                    | 82.5 | 130      | 130    | 130     | 130       | 130                         | 130                      | 129        | 121       | 121      | 118       | 115       | 112      | 111       | 107      | 104       | 107       | 111       | 111       | 112       | 107       |
| A7                                    | 82.5 | 130      | 130    | 130     | 130       | 130                         | 130                      | 126        | 119       | 119      | 114       | 113       | 111      | 110       | 104      | 104       | 104       | 108       | 110       | 110       | 107       |
| A8                                    | 40   | 62       | 62     | 62      | 62        | 62                          | 62                       | 60         | 60        | 60       | 55        | 55        | 54       | 54        | 52       | 50        | 52        | 54        | 54        | 55        | 53        |
| A9                                    | 50   | 68       | 68     | 68      | 68        | 68                          | 68                       | 66         | 66        | 60       | 59        | 59        | 58       | 57        | 55       | 53        | 55        | 57        | 57        | 58        | 57        |
| N1                                    | 82.5 | 130      | 130    | 130     | 130       | 130                         | 130                      | 130        | 130       | 126      | 124       | 121       | 120      | 116       | 108      | 108       | 111       | 116       | 116       | 116       | 114       |
| N2                                    | 82.5 | 130      | 130    | 130     | 130       | 130                         | 130                      | 128        | 124       | 124      | 118       | 117       | 116      | 113       | 106      | 104       | 106       | 115       | 113       | 111       | 110       |
| N3                                    | 82.5 | 130      | 130    | 130     | 130       | 130                         | 130                      | 130        | 126       | 126      | 121       | 118       | 117      | 113       | 109      | 107       | 109       | 113       | 113       | 113       | 112       |
| N4                                    | 82.5 | 130      | 130    | 130     | 130       | 130                         | 130                      | 128        | 126       | 126      | 121       | 118       | 118      | 111       | 109      | 106       | 109       | 111       | 111       | 113       | 113       |
| N5                                    | 82.5 | 130      | 130    | 130     | 130       | 130                         | 130                      | 130        | 130       | 130      | 126       | 124       | 123      | 119       | 115      | 113       | 115       | 119       | 119       | 121       | 127       |
| N6                                    | 82.5 | 130      | 130    | 130     | 130       | 130                         | 130                      | 130        | 130       | 130      | 127       | 124       | 122      | 121       | 119      | 115       | 119       | 119       | 121       | 121       | 121       |
| N7                                    | 82.5 | 127      | 127    | 127     | 127       | 127                         | 127                      | 127        | 127       | 124      | 126       | 126       | 125      | 122       | 115      | 113       | 115       | 122       | 122       | 123       | 121       |
| N8                                    | 95   | 130      | 130    | 130     | 130       | 130                         | 130                      | 130        | 130       | 130      | 130       | 130       | 130      | 129       | 124      | 120       | 124       | 128       | 129       | 129       | 127       |
| Plant Totals                          | 1340 | 2074     | 2074   | 2074    | 2074      | Max Gen Measured:           | 2074                     | 2055       | 1994      | 1937     | 1908      | 1885      | 1840     | 1767      | 1731     | 1767      | 1834      | 1840      | 1861      | 1838      |           |

| Lake Mead Elevation (feet): | 1134      | 1130      | 1126      | 1128      | 1127      | 1126      | 1124      | 1120     | 1116     | 1114      | 1112      | 1114       | 1116      | 1116      | 1116      | 1116      |
|-----------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|----------|-----------|-----------|------------|-----------|-----------|-----------|-----------|
| Date Capacity Effective:    | 5/17/2006 | 6/19/2006 | 9/19/2006 | 2/22/2007 | 3/21/2007 | 3/30/2007 | 4/17/2007 | 5/9/2007 | 6/6/2007 | 6/23/2007 | 7/25/2007 | 12/21/2007 | 1/18/2008 | 2/26/2008 | 3/17/2008 | 3/21/2008 |
|                             | 126       | 124       | 123       | 124       | 124       | 123       | 122       | 120      | 119      | 118       | 117       | 118        | 119       | 119       | 119       | 119       |
|                             | 118       | 117       | 116       | 116       | 116       | 116       | 115       | 113      | 119      | 118       | 117       | 118        | 119       | 119       | 119       | 119       |
|                             | 106       | 104       | 103       | 104       | 104       | 104       | 104       | 102      | 101      | 99        | 99        | 99         | 101       | 101       | 101       | 101       |
|                             | 105       | 104       | 103       | 103       | 103       | 103       | 101       | 100      | 98       | 98        | 97        | 98         | 98        | 98        | 98        | 98        |
|                             | 107       | 106       | 105       | 105       | 109       | 109       | 108       | 107      | 105      | 103       | 103       | 103        | 105       | 105       | 105       | 105       |
|                             | 108       | 107       | 105       | 109       | 112       | 111       | 110       | 109      | 106      | 106       | 105       | 106        | 106       | 106       | 106       | 106       |
|                             | 105       | 104       | 102       | 103       | 103       | 102       | 102       | 100      | 112      | 109       | 109       | 111        | 112       | 112       | 112       | 112       |
|                             | 52        | 52        | 51        | 51        | 51        | 51        | 50        | 50       | 49       | 48        | 48        | 48         | 49        | 49        | 49        | 49        |
|                             | 55        | 55        | 54        | 55        | 55        | 54        | 54        | 53       | 52       | 52        | 51        | 52         | 52        | 52        | 52        | 52        |
|                             | 112       | 110       | 108       | 109       | 109       | 109       | 108       | 106      | 104      | 104       | 103       | 104        | 104       | 104       | 111       | 111       |
|                             | 108       | 107       | 105       | 106       | 106       | 105       | 104       | 103      | 101      | 100       | 99        | 100        | 101       | 111       | 111       | 111       |
|                             | 111       | 110       | 107       | 108       | 108       | 108       | 107       | 105      | 104      | 103       | 102       | 103        | 104       | 104       | 104       | 109       |
|                             | 112       | 110       | 109       | 109       | 109       | 109       | 107       | 106      | 103      | 102       | 103       | 102        | 103       | 103       | 103       | 103       |
|                             | 126       | 124       | 122       | 123       | 123       | 122       | 121       | 120      | 118      | 117       | 116       | 117        | 118       | 118       | 118       | 118       |
|                             | 120       | 118       | 116       | 117       | 117       | 117       | 116       | 114      | 112      | 111       | 111       | 111        | 112       | 112       | 112       | 112       |
|                             | 119       | 117       | 113       | 116       | 116       | 113       | 114       | 113      | 111      | 110       | 109       | 110        | 110       | 111       | 111       | 111       |
|                             | 125       | 124       | 120       | 121       | 121       | 121       | 120       | 119      | 116      | 115       | 115       | 115        | 116       | 116       | 116       | 116       |
| Max Gen Measured:           | 1815      | 1793      | 1762      | 1783      | 1786      | 1777      | 1763      | 1740     | 1730     | 1715      | 1704      | 1715       | 1730      | 1740      | 1747      | 1752      |

**HOOPER POWER PLANT CAPACITY INCREASES ACHIEVED AND FUTURE PLAN**

| Unit Number | Date              | Modification                                | Capacity Increase when Lake Mead is below 1145 (MW) | Cumulative capacity increase when Lake Mead is below 1145 (MW) | Turbine Design Group | Contract Cost | Testing Confirmed MW Capacity Change | Unit Output at Lake Mead 1165 MSL and above (MW) |
|-------------|-------------------|---|---|--|----------------------|---------------|--------------------------------------|--|
| A1          | April 1, 2005     | new stainless gates, stay vane modification | 7   | 7  | Baldwin              | \$878,400     | tested                               | 130  |
| N5          | April 14, 2006    | new stainless gates, stay vane modification | 7   | 14   | Baldwin              | \$816,800     | tested                               | 130  |
| A6          | January 30, 2007  | Overstroke existing gates                   | 6   | 20   | Big Allis            | \$20,000      | tested                               | 130  |
| A5          | February 28, 2007 | Overstroke existing gates                   | 4   | 24   | Big Allis            | \$20,000      | tested                               | 127  |
| A2          | May 23, 2007      | new stainless gates, stay vane modification | 7   | 31   | Baldwin              | \$853,000     | tested                               | 130  |
| A7          | June 6, 2007      | New stainless gates                         | 10  | 41   | Big Allis            | \$910,850     | tested                               | 130  |
| N2          | February 25, 2008 | Overstroke existing gates                   | 10  | 51   | Original Allis       | \$100,000     | estimated                            | 130  |
| N1          | March 13, 2008    | Overstroke existing gates                   | 7   | 58   | Original Allis       | \$100,000     | estimated                            | 130  |
| N3          | March 16, 2008    | Overstroke existing gates                   | 5   | 63   | Original Allis       | \$100,000     | estimated                            | 130  |

**Capacity Improvements with Investments committed and scheduled:**

|    |             |                                |    |    |            |           |           |     |
|----|-------------|--------------------------------|----|----|------------|-----------|-----------|-----|
| N7 | May 4, 2008 | stainless gates, stay vane mod | 7  | 70 | Baldwin    | \$900,000 | estimated | 127 |
| N4 | May 1, 2009 | New stainless gates            | 14 | 84 | Orig Allis | \$843,000 | estimated | 130 |
| N3 | May 1, 2010 | New stainless gates            | 9  | 93 | Orig Allis | \$853,000 | estimated | 130 |
| A6 | May 1, 2011 | New stainless gates            | 6  | 99 | Big Allis  | \$843,000 | estimated | 130 |

**Capacity Improvements not yet scheduled:**

|    |                    |  |   |     |  |  |  |  |
|----|--------------------|--|---|-----|--|--|--|--|
| N1 | future             | stainless gates                        | 7 | 106 |  |  |  |  |
| N2 | future             | stainless gates                        | 4 | 110 |  |  |  |  |
| N3 | future             | stainless gates                        | 9 | 119 |  |  |  |  |
| A5 | future             | more overstroke existing gates         | 4 | 123 |  |  |  |  |
| A5 | future             | stainless gates after all overstroking | 6 | 129 |  |  |  |  |
| A7 | future             | fix stop pins                          | 4 | 133 |  |  |  |  |
| A6 | future             | fix stop pins                          | 2 | 135 |  |  |  |  |
| N8 | payback inadequate | stainless gates                        | 2 | 137 |  |  |  |  |
| A3 | payback inadequate | stainless gates                        | 1 | 138 |  |  |  |  |
| A4 | payback inadequate | stainless gates                        | 1 | 139 |  |  |  |  |

SEE DWG #45-301-9123 for a schematic showing these changes

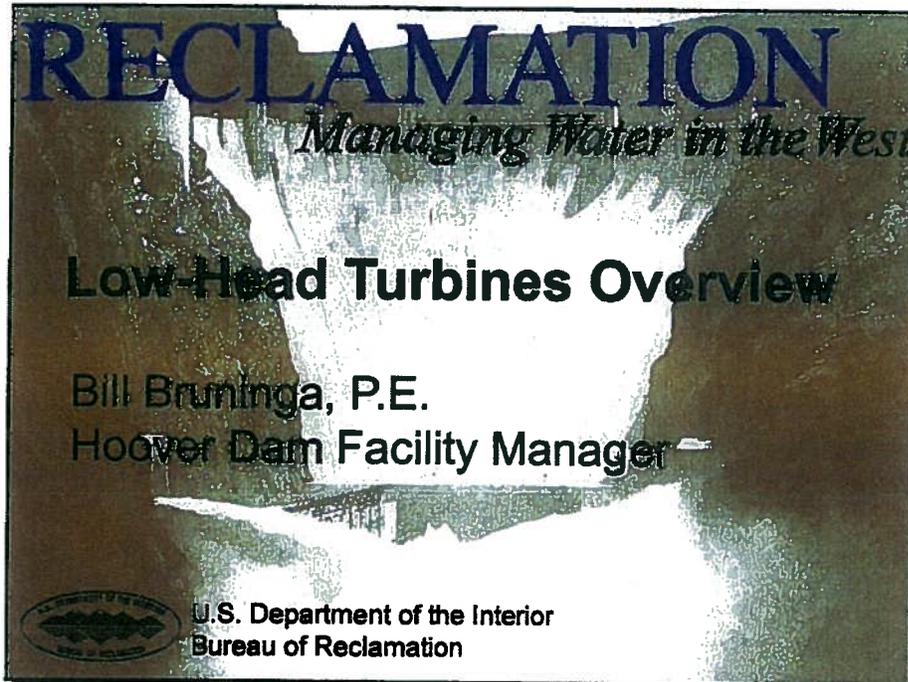
N3 benefit on 5/1/2010 is only 9 MW since 5 MW was achieved with overstroke of existing gates on the same unit previously on 3/16/08.

N2 benefit (future) only 4 MW since 9 MW was achieved with overstroke of existing gates on the same unit previously on 2/25/08.

N1 benefit (future) only 7 MW since 7 MW was achieved with overstroke of existing gates on the same unit previously on 3/13/08.

A6 benefit on 5/1/2011 is only 6 MW since 8 MW was achieved with overstroke of existing gates on the same unit previously on 1/30/07.

|                                       |  |  |  |  |  |  |  |  |
|---------------------------------------|--|--|--|--|--|--|--|--|
| Misc notes on economics:              |  |  |  |  |  |  |  |  |
| value: \$31k per MW per yr            |  |  |  |  |  |  |  |  |
| \$300-500k per MW build new gas plant |  |  |  |  |  |  |  |  |



# RECLAMATION

*Managing Water in the West*

## Low-Head Turbines Overview

Bill Bruninga, P.E.  
Hoover Dam Facility Manager



U.S. Department of the Interior  
Bureau of Reclamation

## Hoover Dam Performance Upgrades

(presented previously)

- Capacity Restoration
  - *Low Head Capacity Increase*
    - Stainless Steel Wicket Gates
    - Low Head Turbines
    - Scroll Case And Draft Tube Coating
    - Wicket Gate Overstroking Upgrades
  - *Tailbay Restoration*
    - Downstream Dredging
- System Integration
  - *Unit Controls Modernization*
    - Unit PLC's
  - *Load-following Optimization*
    - Controls Reprogramming
    - A-8 Rehabilitation
    - Compressed Air Receiver Capacity
- Water Efficiency
  - *Reduced Wicket Gate Leakage*
  - *Nitronics Stainless Steel Seal Rings*
    - Tighter Clearances
    - Longer Useful Life
  - *Reduced Penstock PRV Leakage*
  - *Station Service Generator Upgrade*
    - New Pelton Runners
  - *Electric Cooling Water Pumps Replace Educators*

RECLAMATION

## Performance Upgrades – overview of detailed discussions

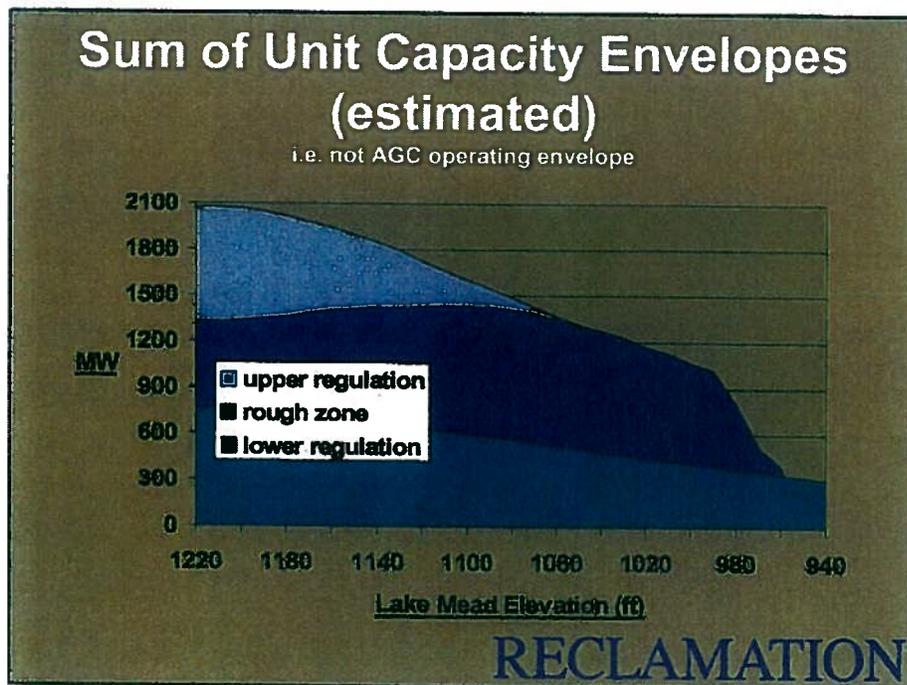
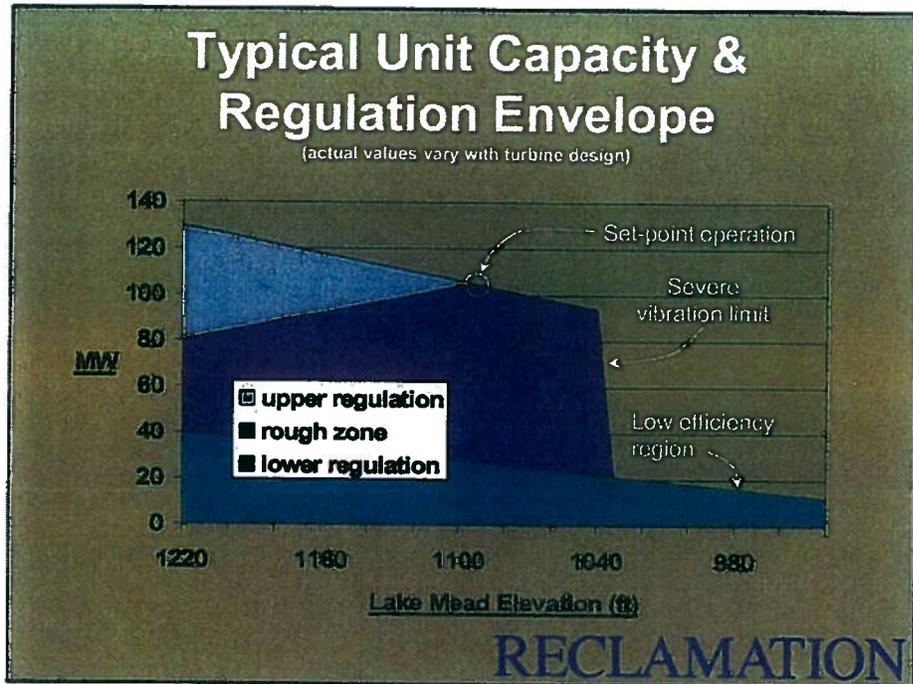
- **Stainless steel wicket gates/overstroking (capacity)**
  - status hand-out
- **Low-Head Turbines vs. lake elevation probabilities (capacity & regulation)**
- **UCM (efficiency)**
  - Details in future presentation
- **“Wide-Head” turbines (efficiency and regulation)**
  - future presentation

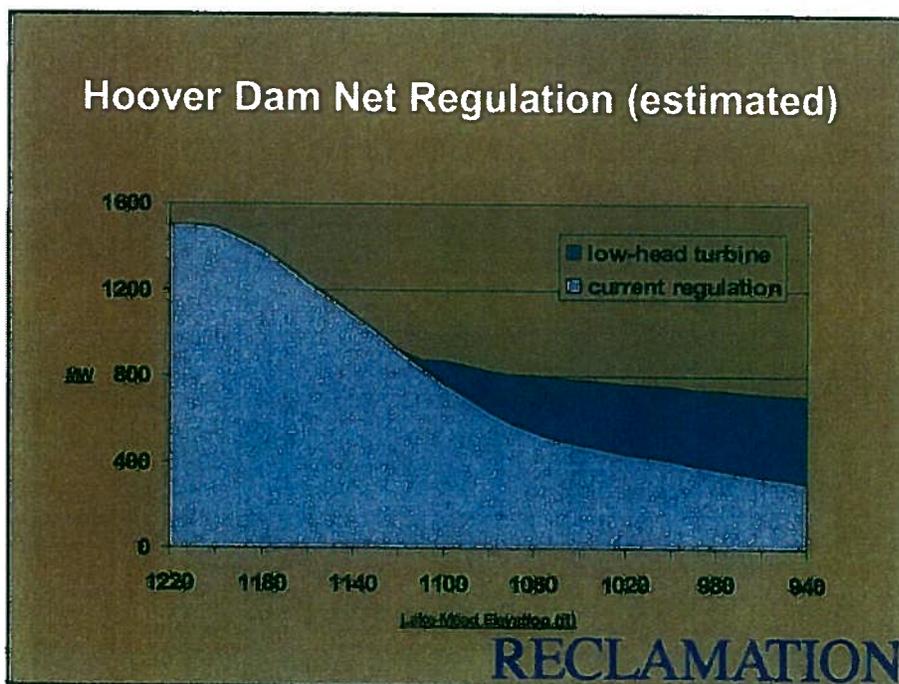
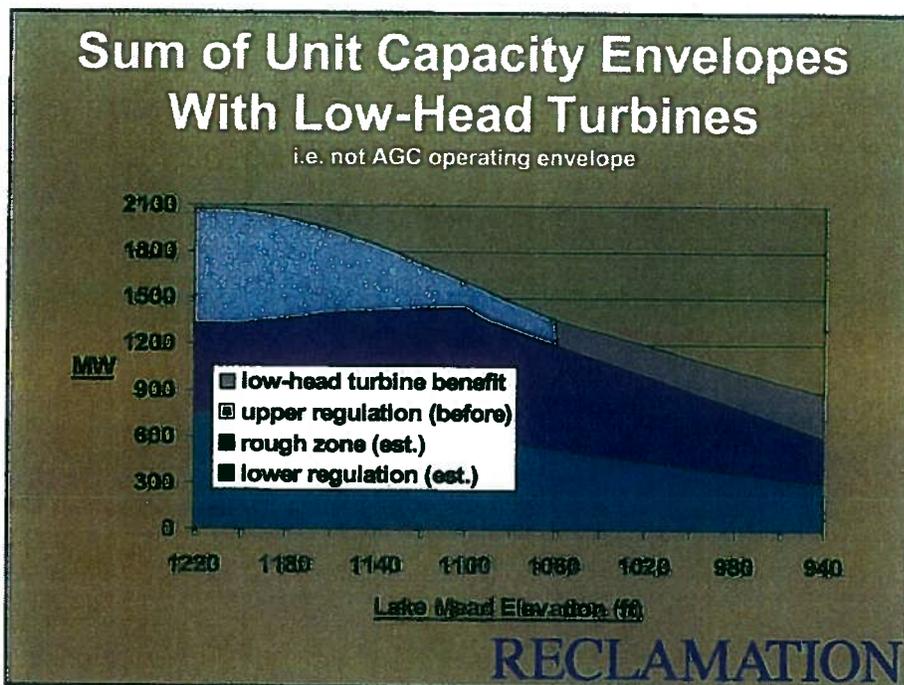
RECLAMATION

## Low-head Turbine Factors

- **Need to understand:**
  - Lake Mead: elevation probabilities over time causing:
    - Plant capacity change over time
    - Plant regulation capability change over time
  - New turbine economics:
    - Cost: development, mfg, installation
    - Benefits: capacity & regulation
  - Ancillary services: ongoing
    - spinning reserve
    - voltage support

RECLAMATION



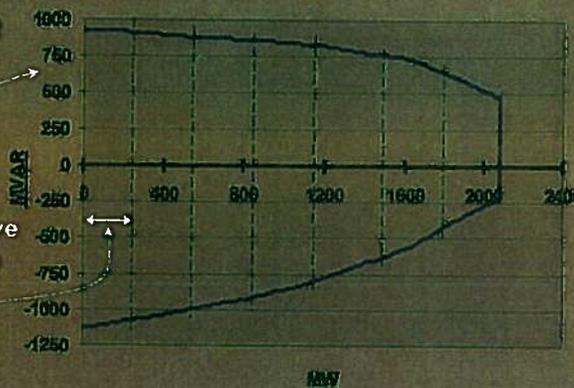


## Hoover Total Reactive Capability

• Regardless of low-head turbine:

– Voltage Support

– Spinning Reserve  
• 10 min. ramp

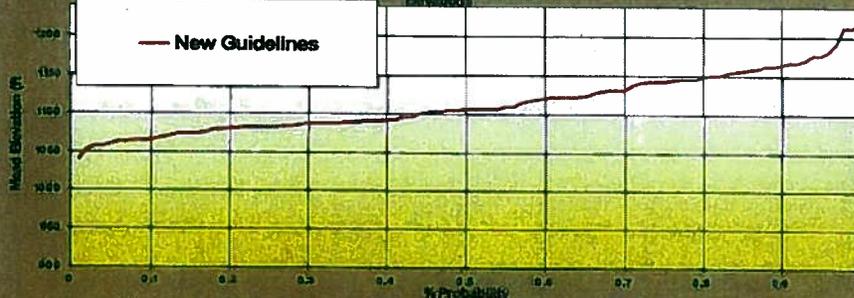


RECLAMATION

## Lake Mead Elevation Probabilities

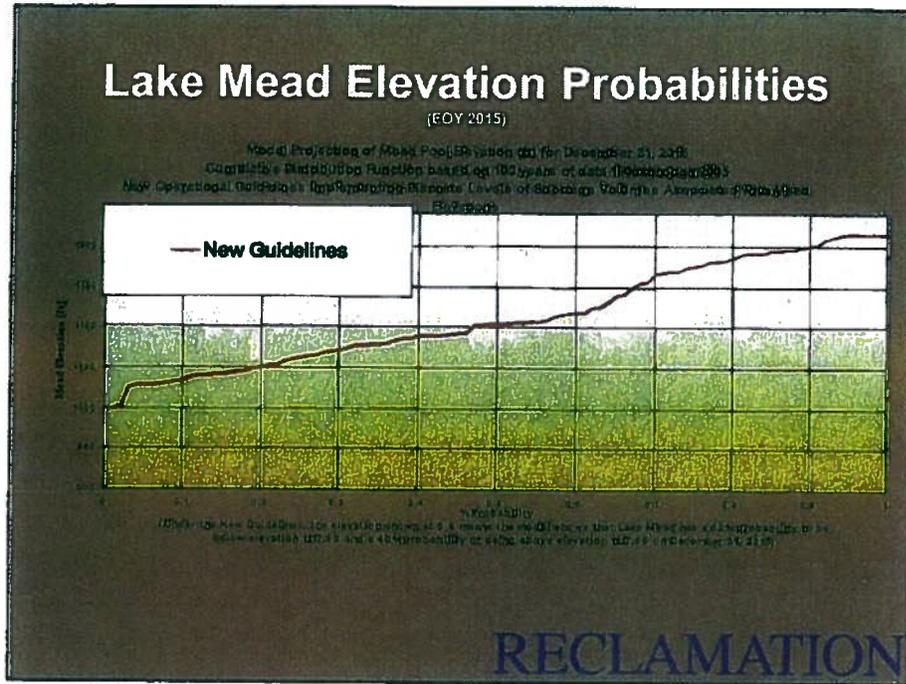
(EOY 2010)

Model Projection of Reservoir Elevation (ft) for December 31, 2010  
 Cumulative Distribution Function based on 100 years of data 1900 through 2000  
 New Operational Guidelines Implementing Discrete Levels of Storage Volumes Associated with Flood  
 Resilience



(Under the New Guidelines, the elevation shown at 90% shows that Lake Mead has a 90% probability to be below elevation 1120.02 and a 10% probability to be above elevation 1120.02 on December 31, 2010.)

RECLAMATION



**APA/RECLAMATION HISTORICAL DATA DIFFERENCES TABLE  
HISTORICAL & PROJECTED HYDROLOGY & GENERATION STATISTICS**

| Year | Boulder Canyon Project<br>Operating Year Statistics |                                     |                              |                            |   |                              | (CY)<br>Natural<br>Flow At<br>Lee' Ferry |                            |                | APA-USBR |
|------|---|-------------------------------------|------------------------------|----------------------------|---|------------------------------|--|----------------------------|----------------|----------|
|      | APA<br>Releases<br>(KAF)                            | USBR Denver<br>CY Releases<br>(KAF) | APA - USBR<br>Delta<br>(KAF) | APA<br>Generation<br>(Gwh) | USBR Denver<br>CY Net Generation<br>(Gwh) | APA - USBR<br>Delta<br>(Gwh) | APA<br>(KAF)                             | USBR/LC Water Ops<br>(KAF) | Delta<br>(KAF) |          |
|      | 1953  | 8,048                               | 8,048                        | 0                          | 4,670                                     | 4,670                        | 0  | 11,165                     | 11,165         | 0        |
| 1954 | 10,564  | 10,564                              | 0                            | 4,022                      | 4,022                                     | 0                            | 8,496                                    | 8,496                      | 0              |          |
| 1955 | 8,111   | 8,111                               | 0                            | 2,967                      | 2,967                                     | 0                            | 9,414                                    | 9,414                      | 0              |          |
| 1956 | 7,852   | 7,852                               | 0                            | 2,648                      | 2,648                                     | 0                            | 11,427                                   | 11,427                     | 0              |          |
| 1957 | 9,309   | 9,309                               | 0                            | 3,594                      | 3,594                                     | 0                            | 21,501                                   | 21,501                     | 0              |          |
| 1958 | 11,865  | 11,865                              | 0                            | 5,087                      | 5,087                                     | 0                            | 15,863                                   | 15,863                     | 0              |          |
| 1959 | 9,277   | 9,277                               | 0                            | 3,814                      | 3,814                                     | 0                            | 9,598                                    | 9,598                      | 0              |          |
| 1960 | 8,951   | 8,951                               | 0                            | 3,664                      | 3,664                                     | 0                            | 11,524                                   | 11,524                     | 0              |          |
| 1961 | 8,543   | 8,543                               | 0                            | 3,367                      | 3,367                                     | 0                            | 10,010                                   | 10,010                     | 0              |          |
| 1962 | 8,570   | 8,570                               | 0                            | 3,549                      | 3,549                                     | 0                            | 17,378                                   | 17,378                     | 0              |          |
| 1963 | 8,489   | 8,489                               | 0                            | 3,354                      | 3,354                                     | 0                            | 8,841                                    | 8,841                      | 0              |          |
| 1964 | 7,252   | 7,252                               | 0                            | 2,882                      | 2,882                                     | 0                            | 10,864                                   | 10,864                     | 0              |          |
| 1965 | 7,749   | 7,749                               | 0                            | 2,669                      | 2,669                                     | 0                            | 19,875                                   | 19,875                     | 0              |          |
| 1966 | 7,736   | 7,736                               | 0                            | 2,868                      | 2,868                                     | 0                            | 10,680                                   | 10,680                     | 0              |          |
| 1967 | 7,807   | 7,807                               | 0                            | 2,924                      | 2,924                                     | 0                            | 11,671                                   | 11,671                     | 0              |          |
| 1968 | 7,794   | 7,794                               | 0                            | 2,914                      | 2,914                                     | 0                            | 13,740                                   | 13,740                     | 0              |          |
| 1969 | 7,848   | 7,848                               | 0                            | 3,016                      | 3,016                                     | 0                            | 15,272                                   | 15,272                     | 0              |          |
| 1970 | 7,980   | 7,980                               | 0                            | 3,184                      | 3,184                                     | 0                            | 15,344                                   | 15,344                     | 0              |          |
| 1971 | 8,120   | 8,120                               | 0                            | 3,197                      | 3,197                                     | 0                            | 15,456                                   | 15,456                     | 0              |          |
| 1972 | 8,055   | 8,055                               | 0                            | 3,251                      | 3,251                                     | 0                            | 13,193                                   | 13,193                     | 0              |          |
| 1973 | 8,258   | 8,258                               | 0                            | 3,417                      | 3,417                                     | 0                            | 18,632                                   | 18,632                     | 0              |          |
| 1974 | 8,688   | 8,688                               | 0                            | 3,553                      | 3,553                                     | 0                            | 13,365                                   | 13,365                     | 0              |          |
| 1975 | 8,323   | 8,323                               | 0                            | 3,450                      | 3,450                                     | 0                            | 17,046                                   | 17,046                     | 0              |          |
| 1976 | 7,883   | 7,883                               | 0                            | 3,511                      | 3,511                                     | 0                            | 11,284                                   | 11,284                     | 0              |          |
| 1977 | 7,828   | 7,754                               | 74                           | 3,570                      | 3,539                                     | 31                           | 5,512                                    | 5,512                      | 0              |          |
| 1978 | 7,433   | 7,433                               | 0                            | 3,417                      | 3,417                                     | 0                            | 15,371                                   | 15,371                     | 0              |          |
| 1979 | 7,684   | 7,684                               | 0                            | 3,594                      | 3,594                                     | 0                            | 17,938                                   | 17,938                     | 0              |          |
| 1980 | 11,021  | 11,021                              | 0                            | 5,106                      | 5,106                                     | 0                            | 17,878                                   | 17,878                     | 0              |          |
| 1981 | 8,269   | 8,269                               | 0                            | 3,648                      | 3,648                                     | 0                            | 8,986                                    | 8,986                      | 0              |          |
| 1982 | 7,435   | 7,435                               | 0                            | 3,265                      | 3,265                                     | 0                            | 17,547                                   | 17,547                     | 0              |          |
| 1983 | 16,934  | 16,934                              | 0                            | 8,224                      | 8,224                                     | 0                            | 24,456                                   | 24,456                     | 0              |          |
| 1984 | 21,377  | 21,377                              | 0                            | 10,348                     | 10,348                                    | 0                            | 25,473                                   | 25,473                     | 0              |          |
| 1985 | 17,224  | 17,215                              | 9                            | 8,153                      | 8,153                                     | 0                            | 20,987                                   | 20,987                     | 0              |          |
| 1986 | 17,530  | 17,530                              | 0                            | 8,284                      | 8,284                                     | 0                            | 23,200                                   | 23,200                     | 0              |          |
| 1987 | 11,322  | 11,322                              | 0                            | 5,250                      | 5,250                                     | 0                            | 15,677                                   | 15,677                     | 0              |          |
| 1988 | 9,410   | 9,410                               | 0                            | 4,507                      | 4,507                                     | 0                            | 11,473                                   | 11,473                     | 0              |          |
| 1989 | 9,150   | 9,150                               | 0                            | 4,348                      | 4,348                                     | 0                            | 10,046                                   | 10,046                     | 0              |          |
| 1990 | 9,190   | 9,190                               | 0                            | 4,287                      | 4,287                                     | 0                            | 9,584                                    | 9,584                      | 0              |          |
| 1991 | 8,938   | 8,938                               | 0                            | 4,013                      | 4,013                                     | 0                            | 12,263                                   | 12,263                     | 0              |          |
| 1992 | 7,814   | 7,814                               | 0                            | 3,595                      | 3,595                                     | 0                            | 10,904                                   | 10,904                     | 0              |          |
| 1993 | 7,422   | 7,422                               | 0                            | 3,452                      | 3,452                                     | 0                            | 18,436                                   | 18,436                     | 0              |          |
| 1994 | 9,338   | 9,338                               | 0                            | 4,310                      | 4,310                                     | 0                            | 10,623                                   | 10,623                     | 0              |          |
| 1995 | 8,529   | 8,526                               | 3                            | 3,856                      | 3,856                                     | 0                            | 20,453                                   | 20,453                     | 0              |          |
| 1996 | 9,966   | 9,966                               | 0                            | 4,659                      | 4,659                                     | 0                            | 14,600                                   | 14,600                     | 0              |          |
| 1997 | 11,627  | 11,627                              | 0                            | 5,568                      | 5,568                                     | 0                            | 21,778                                   | 21,778                     | 0              |          |
| 1998 | 12,738  | 12,738                              | 0                            | 6,202                      | 6,202                                     | 0                            | 16,826                                   | 16,826                     | 0              |          |
| 1999 | 11,008  | 11,008                              | 0                            | 5,329                      | 5,329                                     | 0                            | 16,241                                   | 16,241                     | 0              |          |
| 2000 | 10,674  | 10,656                              | 18                           | 5,103                      | 5,103                                     | 0                            | 10,886                                   | 10,886                     | 0              |          |
| 2001 | 10,192  | 10,192                              | 0                            | 4,746                      | 4,746                                     | 0                            | 10,805                                   | 10,805                     | 0              |          |
| 2002 | 10,434  | 10,434                              | 0                            | 4,683                      | 4,683                                     | 0                            | 6,243                                    | 6,243                      | 0              |          |
| 2003 | 9,369   | 9,369                               | 0                            | 4,034                      | 4,032                                     | 2                            | 10,569                                   | 10,569                     | 0              |          |
| 2004 | 9,624   | 9,336                               | 288                          | 4,021                      | 3,857                                     | 164                          | 9,938                                    | 9,938                      | 0              |          |
| 2005 | 7,935   | 8,273                               | -338                         | 3,255                      | 3,407                                     | -152                         | 16,901                                   | 16,901                     | 0              |          |
| 2006 | 9,399   | 9,260                               | 139                          | 3,852                      | 3,787                                     | 65                           | 13,587                                   | no actual data             | N/A            |          |
| 2007 | 9,463   | 9,361                               | 102                          | 3,807                      | 3,749                                     | 58                           | 12,800                                   | no actual data             | N/A            |          |

fiscal year data

## **BOR RESPONSES TO APA QUESTION #2**

Questions from Customers Related to the Renewal of BCP Contracts in 2017

Question from APA to Western

5/9/08

**QUESTION:** With the improvements made to the turbines and water flow efficiency at Hoover, are there any studies or information that you can share with us regarding additional energy generation availability?

**RESPONSE:** Three improvements have been reviewed at Hoover relative to the efficient conversion of water flow into energy:

- 1) Turbine overhauls
- 2) Installation of Stainless Steel Wicket Gates
- 3) Overhaul of Pressure Relief Valves (PRVs)

### **Turbine overhauls**

Turbine overhauls improve efficiency by restoring seal ring clearances to the design clearance. Hoover has measured a 2% to 3% improvement in efficiency across the load range when comparing efficiency prior to an overhaul to efficiency after an overhaul. (See attached graphs) The efficiency improvement is reduced over the years after an overhaul as operational wear and tear opens the clearances back up. The typical estimated life for a turbine overhaul is 20 years.

The Hoover operation includes many hours of operation to serve Regulation, Ramping, and Reserves (the 3 R's). The overall efficiency of energy production at Hoover Dam is much more heavily influenced by the hours of operation at low loads than by the status of turbine efficiencies. Operation at low loads is determined by customer control area requests and varies by year.

### **Installation of Stainless Steel Wicket Gates**

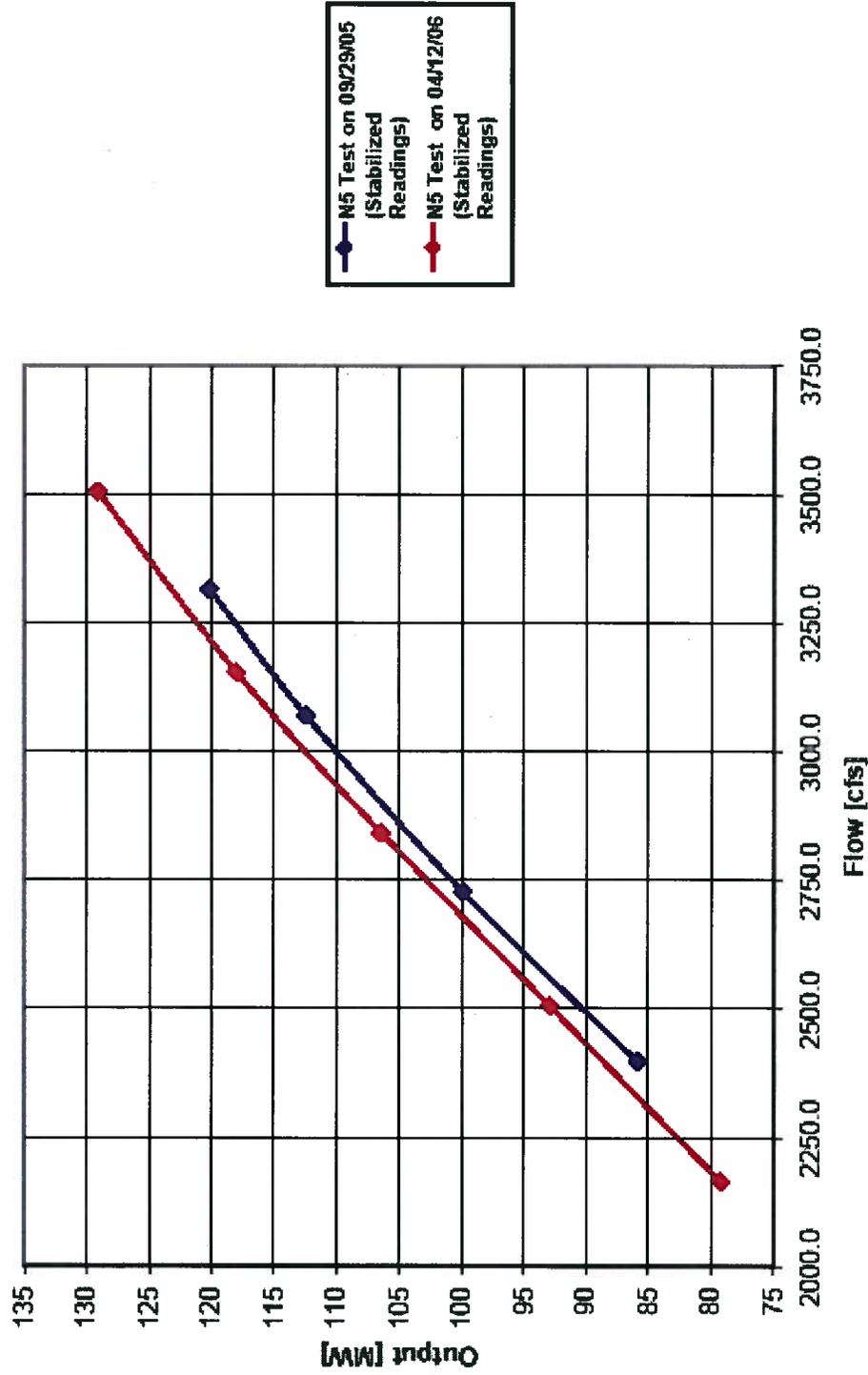
The installation of Stainless Steel Wicket Gates results in capacity improvements at low lake levels. The new wicket gates have a thinner profile and can be opened further to allow more water flow to pass. Capacity improvements of 7 to 10 MW per unit have been achieved by installing stainless steel wicket gates (see attached chart.) The efficiency improvement from the installation of Stainless Steel Wicket Gates is negligible.

### **PRV Overhauls**

PRV Overhauls help insure that the PRV equipment does not leak water at the large valve seat.

# Capacity Improvement from Overhauls and Stainless Steel Gates

N5 Unit Capacity Comparison Before and After Overhaul w/Stainless Steel Gates



# Efficiency Improvement from Overhauls and Stainless Steel Gates

N5 Unit Efficiency Comparison  
Before and After Overhaul w/Stainless Steel Gates

