# APPENDIX I

## SSR REGULATION USING ALTERNATIVE OPERATING STRATEGIES

### I-1. Introduction.

a. This appendix shows the effects of various operating strategies on power generation at Broken Bow Reservoir, Oklahoma, during operating year June 1965-May 1966. This year was selected for routing because its total runoff most closely approximates the average annual runoff for the period of record. The project characteristics are the same as described in Section H-1b of Appendix H. and the project firm energy requirements are those developed in Section H-4.

b. Except as noted, the routings follow the basic procedure outlined in Sections 5-10f and H-3. Tables summarizing the routings are presented for each case, and these tables follow the general format prescribed as Table 5-6 and described on Table 5-7. Although two or more iterations were required in order to achieve balance in some months, only the final iteration is shown in the supporting tables.

c. In the routings, the total discharge in any given period would be defined by one of the following parameters:

- power discharge required to meet firm energy requirements (Column 10) plus 10 cfs leakage losses
- water quality discharge requirements (Column 11)
- net inflow (Column 6), when reservoir is at the top of the conservation pool
- net inflow plus or minus Column 13, the storage draft required to meet end-of-period rule curve elevation
- powerplant hydraulic capacity (2000 cfs) plus 10 cfs
- power discharges required to meet other specified power requirements (Column 10) plus 10 cfs. This applies only to Cases 4 and 5.

In order to make it easier to follow the routings on the tables, the parameter controlling the total discharge for each monthly interval is designated with an asterisk. It should be noted that in some months more than one parameter is involved in establishing the discharge requirement.

d. Energy benefits were computed for the six cases using the energy values shown on Figure I-1. The energy benefit calculations are shown on Table I-9. Table I-1 compares various parameters for the six cases.

I-2. Case 1: Routing to Protect Firm Energy Capability.

a. The primary objective of this routing, which is discussed in Section 5-10h. is to meet firm energy requirements. Hence, storage will be drafted only to meet these requirements. Secondary energy will be generated only when the reservoir is full and the net inflow exceeds the firm energy discharge requirements. This routing strategy will give the maximum assurance that firm energy requirements will be met. but it lacks the flexibility to utilize excess streamflow effectively in good water years.

b. The routing is summarized on Table I-2 and is plotted as Figure 5-35. Heavy runoff in June allowed a large amount of secondary energy to be generated without drafting the power pool. The reservoir was operated essentially as a run-of-river project during this period.

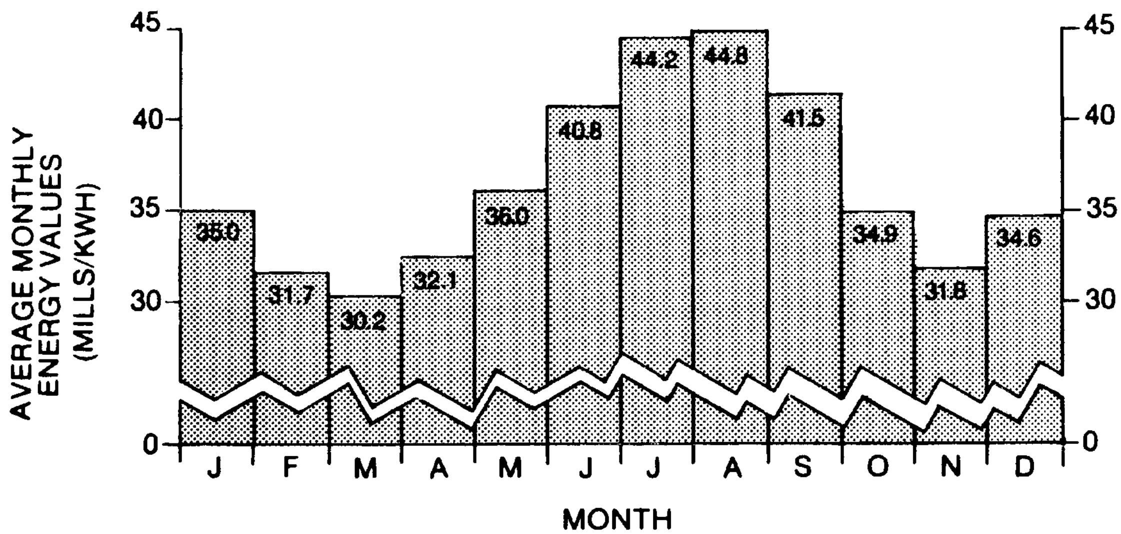


Figure I-1. Monthly energy values

TABLE I-1
Comparisons of Various Parameters for Cases 1 Through 6
for an Average Water Year (1965-66)

| | Case 1 | Case 2 | Case 3 |
|---|---|---|---|
| Average inflow (cfs) | 855 | 855 | 855 |
| Average evaporation (cfs) | -2 | 0 | 1 |
| Average withdrawals (cfs) | 52 | 52 | 52 |
| Average losses (cfs) | 10 | 10 | 10 |
| Average power discharge (cfs) | 796 | 811 | 757 |
| Average pool elev. (Ft, MSL) | 589.4 | 585.0 | 578.6 |
| Average kW/cfs | 13.44 | 13.16 | 12.35 |
| Annual generation (MWh) | 93,710 | 91,850 | 82,050 |
| Generation, percent of Case 1 | 100.0 | 98.0 | 87.6 |
| Spill (AF) | 0 | 0 | 38,300 |
| Annual energy benefit, $1000 1/ | $3,610 | $3,590 | $2,930 |
| Average energy value, mills/kWh | 38.52 | 39.85 | 35.72 |

| | Case 4 | Case 5 | Case 6 |
|---|---|---|---|
| Average inflow (cfs) | 855 | 855 | 855 |
| Average evaporation (cfs) | -2 | -1 | -2 |
| Average withdrawals (cfs) | 52 | 52 | 52 |
| Average losses (cfs) | 10 | 10 | 10 |
| Average power discharge (cfs) | 782 | 796 | 796 |
| Average pool elev. (Ft, MSL) | 598.1 | 585.0 | 594.6 |
| Average kW/cfs | 13.93 | 13.31 | 13.81 |
| Annual generation (MWh) | 95,460 | 92,820 | 96,270 |
| Generation, percent of Case 1 | 101.9 | 99.1 | 102.7 |
| Spill (AF) | 11,300 | 0 | 0 |
| Annual energy benefit, $1000 1/ | $3,350 | $3,770 | $3,560 |
| Average energy value, mills/kWh | 35.11 | 40.62 | 36.94 |

1/ From Table I-9.

From July through January, demands on the reservoir exceeded available inflow, and the pool was drafted to an elevation of 579.9 feet. Heavy inflow in February, April. and May allowed the power pool to refill to maximum elevation, and a total of 9,250 MWh of secondary energy was generated during May. The annual generation for the operating year 1965-66 is 93,710 MWh.

I-3. Case 2: Rule Curve Routing.

a. For this routing, which is described in Section 5-11c, the rule curve derived in Appendix J was used to guide reservoir regulation as follows:

- for each month, the end-of-month rule curve elevations will be met whenever possible.
- the reservoir can be drafted below the rule curve only to meet firm energy requirements.
- the reservoir can be allowed to fill above the rule curve only to avoid spill (i.e., when following the rule curve results in discharges in excess of the powerplant's 2000 cfs hydraulic capacity).

b. The routing is summarized on Table I-3 and is plotted as Figure 5-37. The rule curve is shown as a dashed line on the figure. The reservoir was drafted in June at the powerplant's full 2000 cfs hydraulic capacity. but because of high reservoir inflows, it was not possible to meet the end-of-month rule curve elevation. The rule curve was reached at the end of July. but the reservoir had to be drafted below rule curve from September through January in order to meet firm energy requirements. Refill began in February, but the reservoir was just able to refill by the end of May. It should be noted that the storage will not be completely refilled in every year. However. as long as generation is limited to firm energy requirements whenever the reservoir falls below the rule curve, the reservoir will always be able to meet firm energy requirements without violating the the minimum power pool.

c. The average annual energy output for this case is 91,850 MWh, which is somewhat less than Case 1. However. because more energy is generated in the peak demand months of June and July. when the energy has a higher value, the energy benefits are somewhat higher (see Table I-9).

I-4. Case 3: Routing With Joint Use Storage.

a. Storage Allocation. In this example, which is discussed in Section 5-12e(4), the Broken Bow storage will be divided into three zones, which are primarily defined by the flood control rule curve (Figure 5-40).

| | |
|---|---|
| Top of flood control pool: | El. 604.1 (985.900 AF) |
| Top of joint-use zone: | El. 595.0 (856,400 AF) |
| Bottom of joint-use zone: | El. 568.0 (535.900 AF) |
| Bottom of conservation pool: | El. 559.0 (448,700 AF) |

The project provides 450.000 AF of flood control space, the same as the previous example (see Appendix H), but the full 450,000 AF is provided only in the winter months. During the summer months, it is assumed that only 129,500 AF of flood control space is required. so the remaining (856,400 - 535.900) = 320.500 AF of storage space between El. 595.0 and El. 568.0 (the joint use storage zone) would be available for hydropower regulation. To insure that firm energy requirements are met in the winter months in dry years and to help assure refill in dry years, an additional 87,200 AF of space between El. 559.0 and El. 568.0 is allocated to exclusive power storage.

b. Firm Energy Output. With such a large amount of storage being allocated to winter flood control, very little carry-over of conservation storage is possible. Thus, the project's firm yield will be defined by the single year with the most adverse sequence of flows, instead of the multi-year critical period 1962-65. An examination of the mass diagram (Figure F-2) shows that May 1963-April 1964 is the most adverse water year. and that approximately 256,000 AF is the maximum amount of conservation storage that can be used effectively in that year. However. the flood control rule curve imposes a constraint on refill. By testing alternative firm power storage volumes, it was found that the flood control rule curve limits usable firm power storage to about 218,000 AF (El. 580.0). Thus it is refilled in the previous water year (1962-63), rather than runoff in the critical water year (1963-64), that establishes the firm power storage in this example. Alternative routings for the 1963 refill season are plotted on Figure I-2 to illustrate how the spring flood control rule curve limits the amount of storage that can be counted on as being available by the first of June, 1963. Without the rule curve limit, the reservoir would refill to El. 582.0, and 242,000 AF of firm power storage would be available on June first.

c. Monthly Firm Energy Requirements. A firm energy routing was then made for the 1963-64 critical period, using 218,000 AF of firm power storage and following the procedure outlined in Appendix H. Following are the resulting monthly firm energy requirements.

| | | | |
|---|---|---|---|
| January | 2,980 MWh | July | 5,960 MWh |
| February | 1,790 MWh | August | 5,960 MWh |
| March | 1,790 MWh | September | 2,980 MWh |
| April | 1,790 MWh | October | 1,790 MWh |
| May | 2,980 MWh | November | 1,790 MWh |
| June | 2,980 MWh | December | 2,980 MWh |

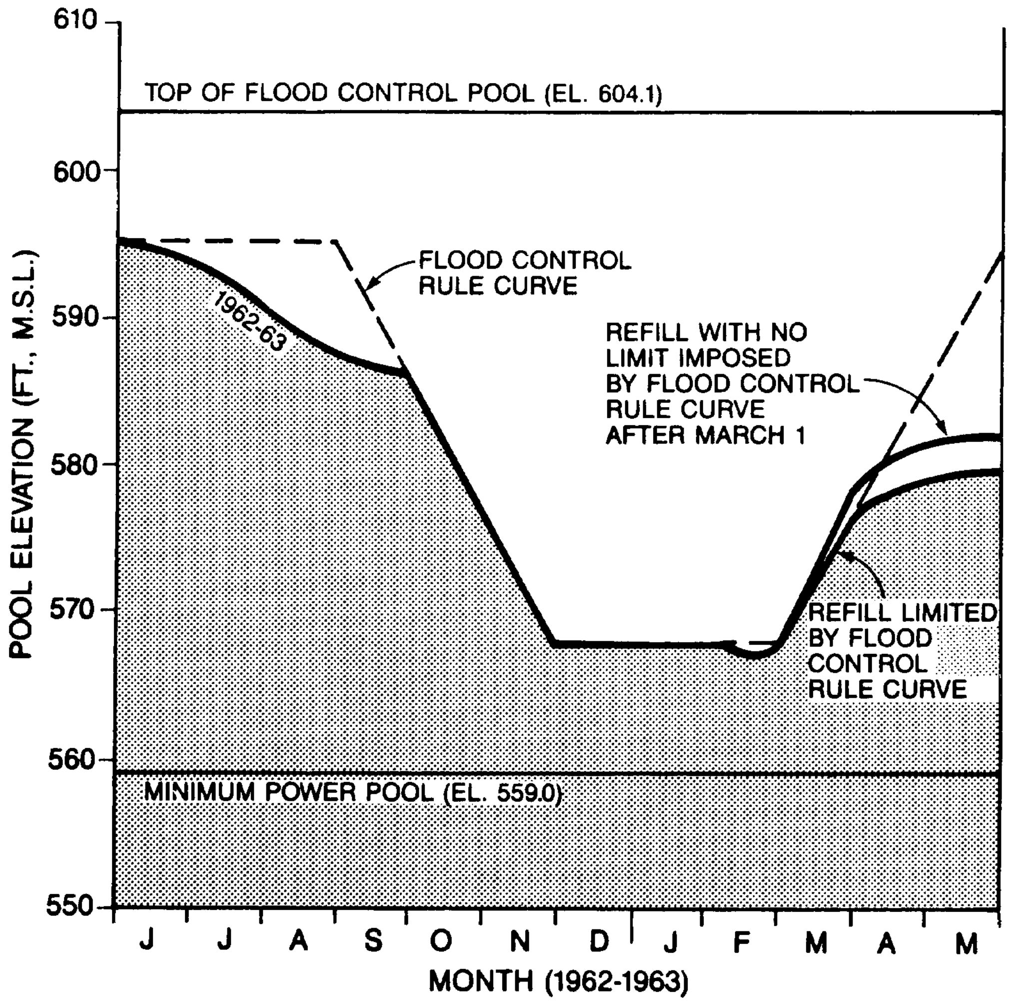


Figure I-2. Routings for 1962-63 water year illustrating impact of spring flood control rule curve on refill

The project would then be routed through the entire period of record using these firm energy requirements and the mandatory flood control rule curve.

d. Operation in an Average Water Year. The routing for 1965-66 is summarized in Table I-4 and plotted as Figure 5-42. In this example, the objective is to meet firm energy requirements, producing secondary energy only when drafts are required to follow the flood control rule curve. The combination of low spring runoff and the constraints imposed by the flood control rule curve resulted in the joint use storage not being completely filled as of the first of June, 1965. Some additional filling was accomplished in June, but the low summer inflows and high firm power discharge requirements resulted in storage drafts to meet firm energy requirements in July. August, and September. In October and November. the flood control rule curve governed drawdown, and secondary energy was produced. In December, energy production was limited to firm requirements, and the reservoir was drafted below the flood control rule curve. In January. moderate inflows permitted regaining the rule curve and allowed generating a small amount of secondary energy. Inflows were high in February, but some water had to be spilled in order to stay on the rule curve. In the spring of 1966, runoff was again insufficient to completely refill the joint use storage, although the firm power storage (El. 580.0) was refilled. The annual energy production would be 82.050 MWh, and the energy benefits would be $2.931.000.

e. Shifting Secondary Energy to Peak Demand Months. In the months of October and November. firm power discharge requirements are low. but large drafts are often required in order to stay on the flood control rule curve. Thus, in most years secondary energy would be produced in these months. Since energy has a substantially higher value in July and August, a preferred operating strategy would be to shift at least part of the secondary energy production to these months. This could be accomplished by discharging as much of the joint use storage in July and August as is possible without jeopardizing firm energy production in subsequent months. Although it would be possible to draft down to the firm energy rule curve, in some years this strategy may result in not refilling the firm power storage in the following spring. A more conservative approach would be to retain enough storage to meet firm energy requirements in September, October. and November, while just reaching the flood control rule curve on December first. The resulting "power rule curve" is shown on Figure I-3. Figure I-4 shows reservoir regulation for the summer and fall of 1965 based on this strategy. and it can be seen how the "power rule curve" sets a limit on the draft in these months. Energy benefits for the year would be $3,200.000. an increase of almost ten percent compared to the routing described in the preceding paragraph. The annual energy production would be reduced slightly due to a lower head in the fall months.

f. Use of Secondary Conservation Storage. The maximum conservation storage space available in the summer months is the storage between the top of the joint use pool (El. 595.0) and the minimum power pool (El. 559.0), or 407,700 AF. Of this, 218,000 AF is reserved for firm power storage (Section I-4b). This leaves (407,700 - 218,000) = 189,700 AF of space available for secondary conservation

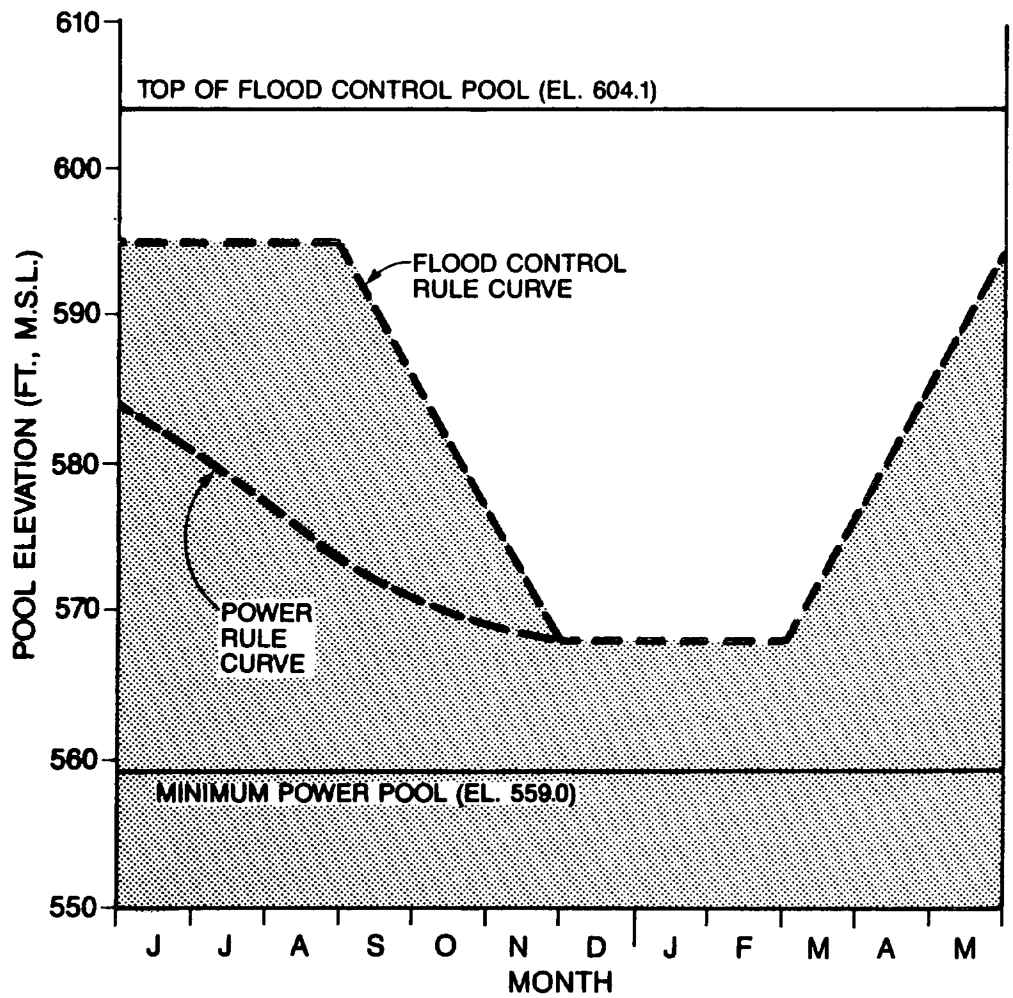


Figure I-3. Power rule curve to limit drawdown in summer months storage (see Figure 5-41). Note that in the example (Table I-4), only 179,400 AF of the 189,700 AF of secondary conservation storage was utilized in this operating year. and only 88,900 AF was available at the start of the next operating year. In Section 5-12e, it was pointed out that the secondary conservation storage space must be filled a reasonably high percentage of the years for it to be economically attractive. By examining the performance of the secondary conservation storage over the entire period of record, it is possible to determine how much space should be allocated to this function. In the case of the example project, it may be determined,

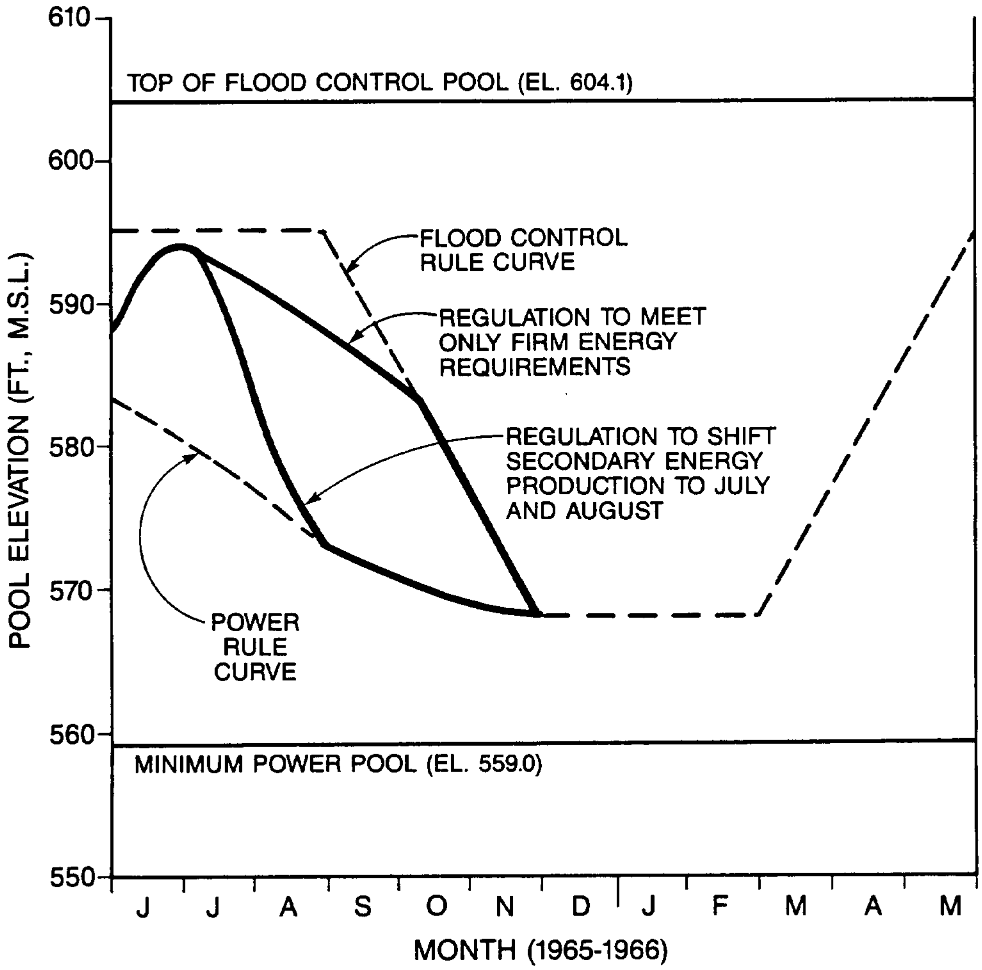


Figure I-4. Regulation in an average water year to shift secondary energy production to the months of July and August, when energy has its highest value for instance, that only 120,000 AF of secondary conservation storage can be used effectively. The top of the joint use pool would then be El. 589.8, and the remaining storage space (between El. 589.8 and El. 599.5) would be allocated to summer flood control.

g. At-Site Recreation. Another consideration is at-site recreation. In most parts of this country, the most satisfactory operation for recreation would be to maintain a constant reservoir elevation between Memorial Day and Labor Day (essentially from June through August). To most closely meet this criteria, the desired power operation would to be to set the top of the conservation pool on the basis of a storage volume that has a high probability of refilling, and to limit energy production in the summer months to firm energy requirements. Also, the modified regulation to increase energy benefits (Section I-4e) would conflict with the objective of maintaining a relatively constant summer pool elevation.

h. Multiple-Purpose Rule Curves. It should be obvious that in order to develop a satisfactory rule curve for regulating joint use storage for flood control, power generation, reservoir recreation, and perhaps other purposes, a careful balancing process is required. It may be necessary to test a large number of alternative operations in order to develop the rule curve which best meets the requirements of all purposes. This would involve testing alternative reservoir sizes and storage allocations as well as rule curve shapes.

I-5. Case 4: Routing to Maximize Average Energy.

a. In this case, which is discussed in Section 5-13b, the objective is to maximize energy output, and this is accomplished by holding the pool at its maximum possible elevation at all times. Thus, it operates essentially as a run-of-river plant. There is no attempt to meet a firm energy requirement, and drafts are made only to meet water quality discharge requirements.

b. The routing is summarized in Table I-5 and is plotted on Figure 5-46. Compared to the base case (Case 1), a higher head is available in most months, with a resulting energy gain. However, this gain is offset by spill in February, so the net energy gain is only 1,750 MWh, or about two percent. Another undesirable feature of this regulation is that only three percent of the energy output for this year occurs in the peak demand months of July and August, while in Case 1, 26 percent of the energy was produced in these months. The average annual generation, at 95.460.000 KWh, is the second highest of the six cases, but the energy benefits, at $3,350,000, are the second lowest (see Table I-1). Note that Case 6, which is designed to maximize dependable capacity, actually produces the maximum energy for this water year.

I-6. Case 5: Routing to Maximize Energy Benefits.

a. The purpose of this routing, which is also discussed in Section 5-13b, is to maximize dollar benefits, and this is accomplished by concentrating as much generation as possible into the peak demand months of June through September. Figure I-1 shows that the value of energy is substantially higher in these months than in other months. It is assumed, for the purposes of this routing, that environmental or recreational considerations would not preclude a large drawdown of the power pool in the summer months.

b. As with the previous routings (except Case 3), it is assumed that the power pool will normally be full at the end of May. During June, the powerplant will be operated at 1000 cfs (fifty percent of the powerplant's hydraulic capacity) or inflow, whichever is greater. During July and August, it is operated at full hydraulic capacity (2000 cfs), and during September, the powerplant backs off again to 1000 cfs. Through the remainder of the year, releases are limited to the water quality discharge requirements, and surplus inflow is used to refill the power storage. An analysis of the most adverse water year (1963-64) shows that the high power discharges can be maintained during the summer months without jeopardizing water quality discharge requirements in later months. However, to insure that problems do not occur in other water years, a rule curve was developed for the low flow discharge requirements by doing a reverse routing starting with the reservoir empty at the end of January 1964 (see Section J-2 of Appendix J). In making the drafts for hydropower in the summer months, the reservoir elevation will not be permitted to fall below that rule curve.

c. The routing for the 1965-66 water year is summarized on Table I-6 and is plotted on Figure 5-46. It can be seen that 63 percent of the usable storage is drafted in the summer months. The annual generation is 92,800 MWh, which is three percent lower than the case to maximize average energy (Case 4), largely due to a lower average head, but the energy benefits, at $3,770,000, are twelve percent higher than for Case 4 (see Table I-1).

I-7. Case 6: Maximize Dependable Capacity.

a. The objective of this routing, which is discussed in Section 5-13c, is to maintain the reservoir at or above the elevation corresponding to the powerplant's rated head. This will insure that the plant's full installed capacity is available at all times. However. just maintaining the pool at or above that elevation is not sufficient. For the capacity to be usable, it must be supported by energy. Therefore, a critical period routing was made based on the power storage above critical head in order to determine the firm energy available for supporting this capacity.

b. It is assumed that Case 6 is a reanalysis of an existing reservoir that was originally designed as described in Appendix H (i.e., where the full storage between El. 559.0 (448,700 AF) and El. 599.5 (918,800 AF) was to be available for hydropower regulation and the objective was to maximize firm energy). It is assumed that the power system resource mix has changed and the hydro project would now serve the system best by providing its full dependable capacity at all times. As originally designed, the units would probably have been rated to provide full capacity down to a head corresponding to (or slightly below) the reservoir elevation with 50 percent of the power storage remaining (see Section 5-5c(8)). Elevation 580.0 (667,000 AF) would therefore be a reasonable assumption for the rated head.

c. Using the storage available between El.580.0 and El. 559.5. monthly preliminary firm energy estimates were derived as described in Section H-2. With only 251,800 AF of power storage available instead of 470,100 AF, it was assumed that the critical period would be one year long, and Figure F-2 shows that 1963-64 is the most adverse single year.

d. Table I-7 shows the final regulation for this period. The generation for the critical drawdown period (June 1963 - January 1964), was 36,460 MWh. of which only 35,000 MWh is considered firm (see below). Using the percentages from Table H-1, the annual firm energy would be (100%/76.7%) x (35,000 MWh) = 45,700 MWh. The corresponding monthly firm energy requirements would be as follows:

| | | | |
|---|---|---|---|
| January (8.33%) | 3,800 MWh | July (16.67%) | 7,600 MWh |
| February (5.0%) | 2,300 MWh | August (16.67%) | 7,600 MWh |
| March (5.0%) | 2,300 MWh | September (8.33%) | 3,800 MWh |
| April (5.0%) | 2,300 MWh | October (5.0%) | 2,300 MWh |
| May (8.33%) | 3,800 MWh | November (5.0%) | 2,300 MWh |
| June (8.33%) | 3,800 MWh | December (8.33%) | 3,800 MWh |

e. Note that the actual generation shown in Table I-7 for October and November exceeded the 2,300 MWh firm energy requirement, because higher discharges were necessary to meet the water quality discharge requirements. In a sense, the full 3,090 MWh generated in October and the 2,970 MWh produced in November are firm, because they can be produced even in the most adverse year. However, since they exceed the 5.0 percent allocated for those months, firm energy credit is limited in this example to the generation corresponding to the 5.0 percent allocation, or 2,300 MWh. In many power systems, there is enough flexibility in the operation of other generating resources to accomodate the deviation from the monthly percentage allocations, and the full generation for these months could be considered firm.

f. A routing was also made for operating year 1965-66 using the firm energy requirements listed above. Storage was drafted only to meet firm energy requirements, so the reservoir remained at the top of power pool during the months of June, 1965 and March through May, 1966. The routing is summarized on Table I-8, and both the critical year routing and 1965-66 routings are plotted as Figure 5-47. The annual generation for 1965-66 is 96,270 MWh.

g. It can be seen that this generation actually exceeds the 95,460 MWh for the case which was intended to maximize average energy (Case 4). This is because the energy that was spilled in February in Case 4 (because of a full reservoir and net inflow in excess of the plant's hydraulic capacity) is converted to usable energy in Case 6. Hence, the regulation strategy followed in Case 6 may prove to be the one that maximizes average energy, rather than Case 4, but the entire period of record would have to be analyzed in order to verify this.

TABLE I-2. Case 1: Routing to Protect

| (1) Routing Interval Month | (2) Year | (3) Inflow 'I' (cfs) | (4) Evaporation 'E' (cfs) | (5) Withdrawals 'W' (cfs) | (6) Net Inflow (cfs) | (7) Energy Requirement (MWh) | (8) Average Pool Elevation (feet) | (9) Net Head or kW/cfs |
|---|---|---|---|---|---|---|---|---|
| May | 1965 | - | - | - | - | - | - | - |
| Jun | 1965 | 1,775 | 37 | 95 | 1,643* | 6,200 | 599.5 | 14.0 |
| Jul | 1965 | 139 | 60 | 94 | -15 | 12,350 | 596.8 | 13.8 |
| Aug | 1965 | 13 | 58 | 94 | -139 | 12,350 | 590.8 | 13.4 |
| Sep | 1965 | 394 | 13 | 66 | 315 | 6,200 | 586.7 | 13.1 |
| Oct | 1965 | 189 | 3 | 33 | 153 | 3,700 | 585.2 | 12.9 |
| Nov | 1965 | 102 | -28 | 25 | 105 | 3,700 | 583.8 | 12.8 |
| Dec | 1965 | 195 | -40 | 24 | 211 | 6,200 | 581.9 | 12.7 |
| Jan | 1966 | 504 | -38 | 24 | 518 | 6,200 | 580.3 | 12.6 |
| Feb | 1966 | 2,701 | -27 | 26 | 2,702 | 3,700 | 585.0 | 12.9 |
| Mar | 1966 | 499 | -19 | 27 | 491 | 3,700 | 590.3 | 13.3 |
| Apr | 1966 | 1,930 | -12 | 37 | 1,905 | 3,700 | 594.0 | 13.6 |
| May | 1966 | 2,021 | -29 | 55 | 1,995* | 6,200 | 598.4 | 13.9 |

* Parameter controlling total discharge for month

Firm Energy Capability

| (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) |
|---|---|---|---|---|---|---|---|---|
| REQUIRED DISCHARGES | | | | | | | | |
| Power 'Q$_p$' (cfs) | Non-power (cfs) | Total (cfs) | Δ STORAGE, $S_1 - S_2$ (cfs) | (AF) | END OF PERIOD RESERVOIR STATUS (AF) | (elev.) | (acres) | Total Energy (MWh) |
| - | - | - | - | - | - | 599.5 | 14,200 | - |
| 615 | 90 | 1,643 | 0 | 0 | 918,800 | 599.5 | 14,200 | 16,460 |
| 1,203* | 120 | 1,213 | -1,228 | -75,500 | 843,300 | 594.0 | 13,500 | 12,350 |
| 1,239* | 173 | 1,249 | -1,388 | -85,300 | 758,000 | 587.5 | 12,600 | 12,350 |
| 657* | 314 | 667 | -352 | -21,000 | 737,000 | 585.8 | 12,400 | 6,200 |
| 386* | 320 | 396 | -243 | -14,900 | 722,100 | 584.6 | 12,200 | 3,700 |
| 401* | 320 | 411 | -306 | -18,800 | 703,300 | 583.1 | 12,100 | 3,700 |
| 656* | 235 | 666 | -455 | -28,000 | 675,300 | 580.7 | 11,700 | 6,200 |
| 661* | 118 | 671 | -153 | -9,400 | 665,900 | 579.9 | 11,600 | 6,200 |
| 427* | 90 | 437 | 2,265 | 125,800 | 791,700 | 590.1 | 12,900 | 3,700 |
| 374* | 86 | 384 | 107 | 6,600 | 798,300 | 590.6 | 13,000 | 3,700 |
| 378* | 86 | 388 | 1,517 | 90,300 | 888,600 | 597.3 | 13,900 | 3,700 |
| 600 | 88 | 1,504 | 491* | 30,200 | 918,800 | 599.5 | 14,200 | 15,450 |

TABLE I-3. Case 2:

| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|
| Routing Interval Month | Year | Inflow 'I' (cfs) | Evapo-ration 'E' (cfs) | With-drawals 'W' (cfs) | Net Inflow (cfs) | Energy Require-ment (MWh) | Average Pool Elevation (feet) | Net Head or kW/cfs |
| May | 1965 | - | - | - | - | - | - | - |
| Jun | 1965 | 1,775 | 36 | 95 | 1,644 | 6,200 | 598.7 | 13.9 |
| Jul | 1965 | 139 | 59 | 94 | -14 | 12,350 | 594.2 | 13.6 |
| Aug | 1965 | 13 | 55 | 94 | -136 | 12,350 | 587.1 | 13.1 |
| Sep | 1965 | 394 | 24 | 66 | 304 | 6,200 | 582.7 | 12.7 |
| Oct | 1965 | 189 | 2 | 33 | 154 | 3,700 | 581.1 | 12.6 |
| Nov | 1965 | 102 | -26 | 25 | 103 | 3,700 | 579.7 | 12.5 |
| Dec | 1965 | 195 | -37 | 24 | 208 | 6,200 | 577.5 | 12.4 |
| Jan | 1966 | 504 | -36 | 24 | 516 | 6,200 | 575.8 | 12.2 |
| Feb | 1966 | 2,701 | -26 | 26 | 2,701 | 3,700 | 580.7 | 12.6 |
| Mar | 1966 | 499 | -18 | 27 | 490 | 3,700 | 586.2 | 13.0 |
| Apr | 1966 | 1,930 | -11 | 37 | 1,904 | 3,700 | 589.9 | 13.3 |
| May | 1966 | 2,021 | -28 | 55 | 1,994 | 6,200 | 596.5 | 13.8 |

1/ Draft limited by powerplant hydraulic capacity (2000 cfs).
* Parameter controlling total discharge for month

Power Rule Curve Routing

| (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) |
|---|---|---|---|---|---|---|---|---|
| REQUIRED DISCHARGES | | | | | | | | |
| Power | Non-power | Total | Δ STORAGE, $S_1 - S_2$ | | END OF PERIOD RESERVOIR STATUS | | | Total Energy |
| '$Q_p$' (cfs) | (cfs) | (cfs) | (cfs) | (AF) | (AF) | (elev.) | (acres) | (MWh) |
| - | - | - | - | - | 918,800 | 599.5 | 14,200 | - |
| 620 | 90 | 2,010 1/ | -366 | -21,800 | 897,000 | 597.9 | 14,000 | 20,020 |
| 1,221 | 120 | 1,599 | -1,613 | -99,200 | 797,800 | 590.6* | 13,000 | 16,180 |
| 1,267* | 173 | 1,277 | -1,413 | -86,900 | 710,300 | 583.6 | 12,100 | 12,350 |
| 678* | 314 | 688 | -384 | -22,900 | 688,000 | 581.8 | 11,900 | 6,200 |
| 395* | 320 | 405 | -251 | -15,400 | 672,600 | 580.5 | 11,700 | 3,700 |
| 411* | 320 | 421 | -318 | -18,900 | 653,700 | 578.8 | 11,500 | 3,700 |
| 673* | 235 | 683 | -475 | -29,200 | 624,500 | 576.3 | 11,200 | 6,200 |
| 683* | 118 | 693 | -177 | -10,900 | 613,600 | 575.3 | 11,100 | 6,200 |
| 437* | 90 | 447 | 2,254 | 125,200 | 738,800 | 586.0 | 12,500 | 3,700 |
| 383* | 86 | 393 | 97 | 6,000 | 744,800 | 586.4 | 12,400 | 3,700 |
| 386* | 86 | 396 | 1,508 | 89,800 | 834,600 | 593.4 | 13,200 | 3,700 |
| 604 | 88 | 625 | 1,369 | 84,200 | 918,800* | 599.5 | 14,100 | 6,200 |

TABLE I-4. Case 3: Routing

| (1) Routing Interval Month | (2) Year | (3) Inflow 'I' (cfs) | (4) Evapo-ration 'E' (cfs) | (5) With-drawals 'W' (cfs) | (6) Net Inflow (cfs) | (7) Energy Require-ment (MWh) | (8) Average Pool Elevation (feet) | (9) Net Head or kW/cfs |
|---|---|---|---|---|---|---|---|---|
| May | 1965 | - | - | - | - | - | - | - |
| Jun | 1965 | 1,775 | 33 | 95 | 1713 | 2,980 | 591.1 | 13.4 |
| Jul | 1965 | 139 | 57 | 94 | -12 | 5,960 | 592.8 | 13.5 |
| Aug | 1965 | 13 | 57 | 94 | -138 | 5,960 | 589.6 | 13.3 |
| Sep | 1965 | 394 | 25 | 66 | 303 | 2,980 | 586.9 | 13.1 |
| Oct | 1965 | 189 | 2 | 33 | 154 | 1,790 | 581.5 | 12.7 |
| Nov | 1965 | 102 | -26 | 25 | 103 | 1,790 | 572.5 | 12.0 |
| Dec | 1965 | 195 | -33 | 24 | 204 | 2,980 | 567.5 | 11.6 |
| Jan | 1966 | 504 | -33 | 24 | 513 | 2,980 | 567.5 | 11.6 |
| Feb | 1966 | 2,701 | -24 | 26 | 2,699* | 1,790 | 568.0 | 11.6 |
| Mar | 1966 | 499 | -15 | 27 | 487 | 1,790 | 568.5 | 11.7 |
| Apr | 1966 | 1,930 | -9 | 37 | 1,902 | 1,790 | 574.2 | 12.1 |
| May | 1966 | 2,021 | -24 | 55 | 1,990 | 2,980 | 583.1 | 12.8 |

1/ This discharge is required in order to stay on the rule curve. Generation is limited to the 2000 cfs hydraulic capacity, so the balance is spilled.

* Parameter controlling total discharge for month

With Joint Use Storage

| (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) |
|---|---|---|---|---|---|---|---|---|
| REQUIRED DISCHARGES | | | | | | | | |
| Power | Non- | | Δ STORAGE, | | END OF PERIOD | | | Total |
| 'Q$_p$' | power | Total | $S_1 - S_2$ | | RESERVOIR STATUS | | | Energy |
| (cfs) | (cfs) | (cfs) | (cfs) | (AF) | (AF) | (elev.) | (acres) | (MWh) |
| - | - | - | - | - | 763,100 | 587.9 | 12,700 | - |
| 309* | 90 | 319 | 1,394 | 83,000 | 846,100 | 594.2 | 13,500 | 2,980 |
| 593* | 120 | 603 | -615 | -37,800 | 808,300 | 591.4 | 13,400 | 5,960 |
| 602* | 173 | 612 | -750 | -46,100 | 762,200 | 587.8 | 12,600 | 5,960 |
| 316 | 314 | 688 | -385 | -22,900 | 739,300 | 586.0* | 12,400 | 6,390 |
| 189 | 320 | 1,889 | -1,735 | -106,700 | 632,600 | 577.0* | 11,300 | 17,750 |
| 207 | 320 | 1,727 | -1,624 | -96,700 | 535,900 | 568.0* | 10,200 | 14,840 |
| 345* | 235 | 355 | -151 | -9,300 | 526,600 | 567.1 | 10,100 | 2,980 |
| 345 | 118 | 362 | 151 | 9,300 | 535,900 | 568.0* | 10,200 | 3,040 |
| 230 | 90 | 2,699 1/ | 0 | 0 | 535,900 | 568.0 | 10,200 | 15,590 |
| 206* | 86 | 216 | 271 | 16,700 | 552,600 | 569.6 | 10,400 | 1,790 |
| 205* | 86 | 215 | 1,687 | 100,500 | 653,100 | 578.8 | 11,500 | 1,790 |
| 313* | 88 | 323 | 1,667 | 102,500 | 755,600 | 587.3 | 12,500 | 2,980 |

TABLE I-5. Case 4: Routing to

| (1) Routing Interval Month | (2) Year | (3) Inflow 'I' (cfs) | (4) Evaporation 'E' (cfs) | (5) Withdrawals 'W' (cfs) | (6) Net Inflow (cfs) | (7) Energy Requirement (MWh) | (8) Average Pool Elevation (feet) | (9) Net Head or kW/cfs |
|---|---|---|---|---|---|---|---|---|
| May | 1965 | - | - | - | - | - | - | - |
| Jun | 1965 | 1,775 | 37 | 95 | 1,643* | - | 599.5 | 14.0 |
| Jul | 1965 | 139 | 60 | 94 | -15 | - | 599.2 | 14.0 |
| Aug | 1965 | 13 | 60 | 94 | -141 | - | 598.2 | 13.9 |
| Sep | 1965 | 394 | 27 | 66 | 301 | - | 597.5 | 13.8 |
| Oct | 1965 | 189 | 3 | 33 | 153 | - | 597.1 | 13.8 |
| Nov | 1965 | 102 | -31 | 25 | 108 | - | 596.2 | 13.7 |
| Dec | 1965 | 195 | -45 | 24 | 216 | - | 595.7 | 13.7 |
| Jan | 1966 | 504 | -45 | 24 | 525 | - | 596.6 | 13.8 |
| Feb | 1966 | 2,701 | -33 | 26 | 2,708* | - | 598.5 | 13.9 |
| Mar | 1966 | 499 | -21 | 27 | 493* | - | 599.5 | 14.0 |
| Apr | 1966 | 1,930 | -13 | 37 | 1,906* | - | 599.5 | 14.0 |
| May | 1966 | 2,021 | -29 | 55 | 1,995* | - | 599.5 | 14.0 |

1/ The required discharge exceeded the powerplant hydraulic capacity, so 213 cfs of spill was required.
* Parameter controlling total discharge for month

Maximize Average Energy

| (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) |
|---|---|---|---|---|---|---|---|---|
| REQUIRED DISCHARGES | | | | | | | | |
| Power 'Q$_p$' (cfs) | Non-power (cfs) | Total (cfs) | Δ STORAGE, $S_1 - S_2$ (cfs) | (AF) | END OF PERIOD RESERVOIR STATUS (AF) | (elev.) | (acres) | Total Energy (MWh) |
| - | - | - | - | - | 918,800 | 599.5 | 14,200 | - |
| - | 90 | 1,643 | 0 | 0 | 918,800 | 599.5 | 14,200 | 16,460 |
| - | 120* | 120 | -135 | - 8,300 | 910,500 | 598.9 | 14,100 | 1,150 |
| - | 173* | 173 | -314 | -19,300 | 891,200 | 597.5 | 13,900 | 1,690 |
| - | 314* | 314 | -13 | -800 | 890,400 | 597.5 | 13,900 | 3,020 |
| - | 320* | 320 | -167 | -10,300 | 880,100 | 596.7 | 13,800 | 3,180 |
| - | 320* | 320 | -212 | -12,600 | 867,500 | 595.8 | 13,700 | 3,060 |
| - | 235* | 235 | -19 | -1,200 | 866,300 | 595.7 | 13,700 | 2,290 |
| - | 118* | 118 | 407 | 25,000 | 891,300 | 597.5 | 13,900 | 1,110 |
| - | 90 | 2,213 | 1/ 495* | 27,500 | 918,800 | 599.5 | 14,200 | 18,680 |
| - | 86 | 493 | 0 | 0 | 918,800 | 599.5 | 14,200 | 5,030 |
| - | 86 | 1,906 | 0 | 0 | 918,800 | 599.5 | 14,200 | 19,110 |
| - | 88 | 1,995 | 0 | 0 | 918,800 | 599.5 | 14,200 | 20,680 |

TABLE I-6. Case 5:

| (1) Routing Interval Month | (2) Year | (3) Inflow 'I' (cfs) | (4) Evapo-ration 'E' (cfs) | (5) With-drawals 'W' (cfs) | (6) Net Inflow (cfs) | (7) Energy Require-ment (MWh) | (8) Average Pool Elevation (feet) | (9) Net Head or kW/cfs |
|---|---|---|---|---|---|---|---|---|
| May | 1965 | - | - | - | - | - | - | - |
| Jun | 1965 | 1,775 | 37 | 95 | 1,643* | - | 599.5 | 14.0 |
| Jul | 1965 | 139 | 59 | 94 | -14 | - | 594.9 | 13.6 |
| Aug | 1965 | 13 | 49 | 94 | -130 | - | 585.0 | 12.9 |
| Sep | 1965 | 394 | 23 | 66 | 305 | - | 577.8 | 12.4 |
| Oct | 1965 | 189 | 2 | 33 | 154 | - | 575.5 | 12.2 |
| Nov | 1965 | 102 | -25 | 25 | 102 | - | 574.4 | 12.1 |
| Dec | 1965 | 195 | -36 | 24 | 207 | - | 573.8 | 12.1 |
| Jan | 1966 | 504 | -36 | 24 | 516 | - | 574.8 | 12.2 |
| Feb | 1966 | 2,701 | -26 | 26 | 2,701 | - | 582.0 | 12.7 |
| Mar | 1966 | 499 | -19 | 27 | 491 | - | 589.1 | 13.2 |
| Apr | 1966 | 1,930 | -12 | 37 | 1,905 | - | 594.1 | 13.6 |
| May | 1966 | 2,021 | -29 | 55 | 1,995* | - | 598.8 | 13.9 |

* Parameter controlling total discharge for month

Routing to Maximize Energy Benefits

| (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) |
|---|---|---|---|---|---|---|---|---|
| REQUIRED DISCHARGES | | | Δ STORAGE, $S_1 - S_2$ | | END OF PERIOD RESERVOIR STATUS | | | Total Energy |
| Power '$Q_p$' (cfs) | Non-power (cfs) | Total (cfs) | (cfs) | (AF) | (AF) | (elev.) | (acres) | (MWh) |
| - | - | - | - | - | 918,800 | 599.5 | 14,200 | - |
| 1,000 | 90 | 1643 | 0 | 0 | 918,800 | 599.5 | 14,200 | 16,460 |
| 2,000* | 120 | 2010 | -2,024 | -124,500 | 794,300 | 590.3 | 13,000 | 20,240 |
| 2,000* | 173 | 2010 | -2,140 | -131,600 | 662,700 | 579.6 | 11,600 | 19,200 |
| 1,000* | 314 | 1010 | -705 | -42,000 | 620,700 | 575.9 | 11,100 | 8,930 |
| - | 320* | 320 | -166 | -10,200 | 610,500 | 575.0 | 11,000 | 2,810 |
| - | 320* | 320 | -218 | -13,000 | 597,500 | 573.8 | 10,900 | 2,700 |
| - | 235* | 235 | -28 | -1,700 | 595,800 | 573.7 | 10,900 | 2,030 |
| - | 118* | 118 | 398 | 24,500 | 620,300 | 575.9 | 11,100 | 980 |
| - | 90* | 90 | 2,611 | 145,000 | 765,300 | 588.1 | 12,700 | 680 |
| - | 86* | 86 | 4052 | 24,900 | 790,200 | 590.0 | 12,900 | 750 |
| - | 86* | 86 | 1,819 | 108,300 | 898,500 | 598.1 | 14,000 | 740 |
| - | 88 | 1,665 | 330* | 20,300 | 918,800 | 599.5 | 14,200 | 17,120 |

TABLE I-7. Case 6: Routing to Maximize

| (1) Routing Interval Month | (2) Year | (3) Inflow 'I' (cfs) | (4) Evapo-ration 'E' (cfs) | (5) With-drawals 'W' (cfs) | (6) Net Inflow (cfs) | (7) Energy Require-ment (MWh) | (8) Average Pool Elevation (feet) | (9) Net Head or kW/cfs |
|---|---|---|---|---|---|---|---|---|
| May | 1963 | - | - | - | - | - | - | - |
| Jun | 1963 | 36 | 37 | 95 | -96 | 3,800 | 598.5 | 13.9 |
| Jul | 1963 | 65 | 58 | 94 | -87 | 7,600 | 595.5 | 13.7 |
| Aug | 1963 | 43 | 57 | 94 | -108 | 7,600 | 591.6 | 13.4 |
| Sep | 1963 | 19 | 25 | 66 | -72 | 3,800 | 588.4 | 13.2 |
| Oct | 1963 | 0 | 2 | 33 | -35 | 2,300 | 586.4 | 13.0 |
| Nov | 1963 | 0 | -29 | 25 | 4 | 2,300 | 584.8 | 12.9 |
| Dec | 1963 | 15 | -39 | 24 | 30 | 3,800 | 583.0 | 12.8 |
| Jan | 1964 | 15 | -38 | 24 | 29 | 3,800 | 581.0 | 12.6 |
| Feb | 1964 | 338 | -28 | 26 | 340 | 2,300 | 580.2 | 12.5 |
| Mar | 1964 | 2,436 | -17 | 27 | 2,426 | 2,300 | 585.7 | 13.0 |
| Apr | 1964 | 2,851 | -12 | 37 | 2,828* | 2,300 | 595.3 | 13.7 |
| May | 1964 | 457 | -29 | 55 | 431* | 3,800 | 599.5 | 14.0 |

* Parameter controlling total discharge for month

Dependable Capacity (Critical Year Routing)

| (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) |
|---|---|---|---|---|---|---|---|---|
| REQUIRED DISCHARGES | | | | | | | | |
| Power | Non- | | Δ STORAGE, | | END OF PERIOD | | | Total |
| '$Q_p$' | power | Total | $S_1 - S_2$ | | RESERVOIR STATUS | | | Energy |
| (cfs) | (cfs) | (cfs) | (cfs) | (AF) | (AF) | (elev.) | (acres) | (MWh) |
| - | - | - | - | - | 918,800 | 599.5 | 14,200 | - |
| 380* | 90 | 390 | -486 | -28,900 | 889,600 | 597.4 | 13,900 | 3,800 |
| 746* | 120 | 756 | -843 | -51,800 | 837,800 | 593.6 | 13,900 | 7,600 |
| 762* | 173 | 772 | -880 | -54,100 | 783,700 | 589.5 | 12,900 | 7,600 |
| 400* | 314 | 410 | -482 | -28,700 | 755,000 | 587.3 | 12,600 | 3,800 |
| 238 | 320* | 320 | -355 | -21,800 | 733,200 | 585.5 | 12,300 | 3,090 |
| 248 | 320* | 320 | -316 | -18,800 | 714,400 | 584.0 | 12,200 | 2,970 |
| 399* | 235 | 409 | -379 | -23,300 | 691,100 | 582.0 | 11,900 | 3,800 |
| 405* | 118 | 415 | -386 | -23,700 | 667,400 | 580.0 | 11,700 | 3,800 |
| 274* | 90 | 284 | 56 | 3,100 | 670,500 | 580.3 | 11,700 | 2,300 |
| 238* | 86 | 248 | 2,178 | 133,900 | 804,400 | 591.1 | 13,100 | 2,300 |
| 233 | 86 | 907 | 1,921* | 114,400 | 918,800 | 599.5 | 14,200 | 8,950 |
| 365 | 88 | 431 | 0 | 0 | 918,800 | 599.5 | 14,200 | 4,490 |

TABLE I-8. Case 6: Routing to Maximize

| (1) Routing Interval Month | (2) Year | (3) Inflow 'I' (cfs) | (4) Evapo-ration 'E' (cfs) | (5) With-drawals 'W' (cfs) | (6) Net Inflow (cfs) | (7) Energy Require-ment (MWh) | (8) Average Pool Elevation (feet) | (9) Net Head or kW/cfs |
|---|---|---|---|---|---|---|---|---|
| May | 1965 | - | - | - | - | - | - | - |
| Jun | 1965 | 1,775 | 37 | 95 | 1,643* | 3,800 | 599.5 | 14.0 |
| Jul | 1965 | 139 | 60 | 94 | -15 | 7,600 | 597.0 | 13.8 |
| Aug | 1965 | 13 | 58 | 94 | -139 | 7,600 | 594.0 | 13.6 |
| Sep | 1965 | 394 | 26 | 66 | 302 | 3,800 | 591.8 | 13.4 |
| Oct | 1965 | 189 | 2 | 33 | 154 | 2,300 | 591.2 | 13.4 |
| Nov | 1965 | 102 | -30 | 25 | 107 | 2,300 | 590.3 | 13.3 |
| Dec | 1965 | 195 | -42 | 24 | 213 | 3,800 | 589.4 | 13.2 |
| Jan | 1966 | 504 | -42 | 24 | 522 | 3,800 | 589.2 | 13.2 |
| Feb | 1966 | 2,701 | -30 | 26 | 2,705* | 2,300 | 594.5 | 13.6 |
| Mar | 1966 | 499 | -21 | 27 | 496* | 2,300 | 599.5 | 14.0 |
| Apr | 1966 | 1,930 | -13 | 37 | 1,906* | 2,300 | 599.5 | 14.0 |
| May | 1966 | 2,021 | -29 | 55 | 1,995* | 3,800 | 599.5 | 14.0 |

* Parameter controlling total discharge for month

Dependable Capacity (Average Year Routing)

| (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) |
|---|---|---|---|---|---|---|---|---|
| REQUIRED DISCHARGES | | | | | | | | |
| Power '$Q_p$' (cfs) | Non-power (cfs) | Total (cfs) | Δ STORAGE, $S_1 - S_2$ (cfs) | (AF) | END OF PERIOD RESERVOIR STATUS (AF) | (elev.) | (acres) | Total Energy (MWh) |
| - | - | - | - | - | 918,800 | 599.5 | 14,200 | - |
| 377 | 90 | 1,643 | 0 | 0 | 918,800 | 599.5 | 14,200 | 16,460 |
| 741* | 120 | 751 | -766 | -47,100 | 871,700 | 596.1 | 13,700 | 7,600 |
| 751* | 173 | 761 | -900 | -55,300 | 816,400 | 592.0 | 13,200 | 7,600 |
| 394* | 314 | 404 | -102 | - 6,100 | 810,300 | 591.6 | 13,100 | 3,800 |
| 231 | 320* | 320 | -166 | -10,200 | 800,100 | 590.8 | 13,000 | 3,090 |
| 240 | 320* | 320 | -213 | -12,700 | 787,400 | 589.8 | 12,900 | 2,970 |
| 387* | 235 | 397 | -184 | -11,300 | 776,100 | 588.9 | 12,800 | 3,800 |
| 387* | 118 | 397 | 125 | 7,700 | 783,800 | 589.5 | 12,900 | 3,800 |
| 252 | 90 | 262 | 2,431* | 135,000 | 918,800 | 599.5 | 14,200 | 2,300 |
| 221 | 86 | 496 | 0 | 0 | 918,800 | 599.5 | 14,200 | 5,060 |
| 228 | 86 | 1,906 | 0 | 0 | 918,800 | 599.5 | 14,200 | 19,110 |
| 365 | 88 | 1,995 | 0 | 0 | 918,800 | 599.5* | 14,200 | 20,680 |

TABLE I-9. Summary of Monthly Energy

| Routing Interval | Monthly Energy Value (Mills/kWh) | Case 1 Energy (MWh) | Case 1 Energy Benefit ( $ ) | Case 2 Energy (MWh) | Case 2 Energy Benefit ( $ ) |
|---|---|---|---|---|---|
| June 1965 | 40.80 | 16,460 | 671,600 | 20,020 | 816,800 |
| July 1965 | 44.20 | 12,350 | 545,900 | 16,180 | 715,200 |
| Aug. 1965 | 44.80 | 12,350 | 553,300 | 12,350 | 553,300 |
| Sep. 1965 | 41.50 | 6,200 | 257,300 | 6,200 | 257,300 |
| Oct. 1965 | 34.90 | 3,700 | 129,100 | 3,700 | 129,100 |
| Nov. 1965 | 31.80 | 3,700 | 117,700 | 3,700 | 117,700 |
| Dec. 1965 | 34.60 | 6,200 | 214,500 | 6,200 | 214,500 |
| Jan. 1966 | 35.00 | 6,200 | 217,000 | 6,200 | 217,000 |
| Feb. 1966 | 31.70 | 3,700 | 117,300 | 3,700 | 117,300 |
| Mar. 1966 | 30.20 | 3,700 | 111,700 | 3,700 | 111,700 |
| Apr. 1966 | 32.10 | 3,700 | 118,800 | 3,700 | 118,800 |
| May 1966 | 36.00 | 15,450 | 556,200 | 6,200 | 223,200 |
| Annual Totals | | 93,710 | 3,610,400 | 91,850 | 3,591,900 |

Outputs and Benefits: Cases 1 through 6

| Case 3 | | Case 4 | | Case 5 | | Case 6 | |
|---|---|---|---|---|---|---|---|
| Energy (MWh) | Energy Benefits ( $ ) | Energy (MWh) | Energy Benefit ( $ ) | Energy (MWh) | Energy Benefit ( $ ) | Energy (MWh) | Energy Benefit ( $ ) |
| 2,980 | 121,600 | 16,460 | 671,600 | 16,460 | 671,600 | 16,460 | 671,600 |
| 5,960 | 263,400 | 1,150 | 50,800 | 20,240 | 894,600 | 7,600 | 335,900 |
| 5,960 | 267,000 | 1,690 | 75,700 | 19,200 | 860,200 | 7,600 | 340,500 |
| 6,390 | 265,200 | 3,020 | 125,300 | 8,930 | 370,600 | 3,800 | 157,700 |
| 17,750 | 619,500 | 3,180 | 111,000 | 2,810 | 98,100 | 3,090 | 107,800 |
| 14,840 | 471,900 | 3,060 | 97,300 | 2,700 | 85,900 | 2,970 | 94,400 |
| 2,980 | 103,100 | 2,290 | 79,200 | 2,030 | 70,200 | 3,800 | 131,500 |
| 3,040 | 106,400 | 1,110 | 38,900 | 980 | 34,300 | 3,800 | 133,000 |
| 15,590 | 494,200 | 18,680 | 592,200 | 680 | 21,600 | 2,300 | 72,900 |
| 1,790 | 54,100 | 5,030 | 151,900 | 750 | 22,700 | 5,060 | 152,800 |
| 1,790 | 57,500 | 19,110 | 613,400 | 7,400 | 23,800 | 19,110 | 613,400 |
| 2,980 | 107,300 | 20,680 | 744,500 | 17,120 | 616,300 | 20,680 | 744,500 |
| 82,050 | 2,931,200 | 95,460 | 3,351,800 | 92,820 | 3,769,900 | 96,270 | 3,556,000 |