CHAPTER XI. ECONOMICS

This chapter contains estimates of the economic impacts of implementing the flow objectives alternatives. Impacts on agricultural water users are presented in the first section of the chapter and impacts on urban water users are presented in the second section. Estimates of the impacts on regional economies resulting from reduced agricultural production follow in the third section. An overview of the economic impacts is at the end of this chapter.

A. IMPACTS ON AGRICULTURAL WATER USERS

The proposed alternatives will affect the amount of water delivered to farms by irrigation districts in the Central Valley. In addition, Alternatives 3 and 4 will affect the amount of water that farms can divert from the Sacramento and San Joaquin rivers under their water rights.

If water deliveries are reduced, farmers will likely fallow acreage and change crops. In many cases, farmers will be able to pump additional groundwater, use water transferred from other areas, use what water they have on high-valued crops, and improve their irrigation systems. These actions will offset the impacts of reduced deliveries. Nevertheless, agricultural production in the long run will be reduced because less water will be available overall. Farmers' incomes will be reduced, both because production will be reduced and because groundwater and transferred water will be more expensive than project water. Reduced production will also result in job losses in agriculture and other industries in the areas affected by the reduced deliveries. These impacts are discussed in section D of this chapter.

The cost that the alternatives will impose on farmers is measured as the impact of the flow objectives on producers' net income. Producers' net income is defined as crop production receipts less operating costs. Operating costs include labor, fuel, seed, chemicals, and groundwater pumping. In other words, producers' net income is the return to land, improvements, management, and business risk. Because producers' net income includes the return to land and improvements, impacts on producers' net income include impacts on land values.

Impacts on gross crop production are also presented. These figures do not represent the impact on agriculture because about half of gross production receipts is spent on operating costs, which fall as production is curtailed. However, impacts on gross production are useful for comparison with production trends in recent years.

1. Water Supply Impacts

The economic analysis is based on estimates of water deliveries obtained from DWRSIM modeling studies. The modeling studies specify deliveries in the 73 years of historical hydrology under D-1485 and under each of the seven alternatives for implementing the flow objectives in the Bay/Delta Plan. DWRSIM is discussed in Chapter IV. Water deliveries given by the DWRSIM

Table XI-1
Regions Used in the Economic Analysis

Region	CVPM Regions	Description
A. Shasta, Tehama	1,2	Anderson Valley, Tehama County, north part of Glenn County.
B. Glenn, Colusa	3,4	Glenn and Colusa counties, northern Yolo County, Sacramento River.
C. Feather River	5,7	East side of Sacramento Valley from central Butte County to northern Sacramento County.
D. Yolo, Solano, Delta	6,9	Yolo and Solano Counties, Delta.
E. Sacramento, San Joaquin	8	South-central Sacramento County, east San Joaquin County, northern Stanislaus County.
F. Delta-Mendota	10	Delta-Mendota Canal service area.
G. Modesto-Oakdale-Turlock	11,12	Stanislaus River water rights, Modesto ID, Oakdale ID, Turlock ID.
H. Merced-Madera	13	Merced ID, Madera, Chowchilla, Gravelly Ford.
J. Westlands	14	Westlands WD, parts of Fresno Slough, James, Tranquility, San Luis WDs.
K. Kings-Tulare-E. Fresno	15-18	Tulare Lake bed, Friant-Kern Canal service area, eastern Fresno County.
L. Kern County	19-21	Kern County portion of San Joaquin Valley floor.

The regions used in the economic analysis are groups of the regions used in the Central Valley Production Model (CVPM). See section 3 of this chapter for more information on the CVPM.

studies were aggregated into the regions used in the economic analysis. These regions are listed in Table XI-1 and shown in Figure XI-1.

An analysis of economic impacts in every year for which simulated water deliveries are available is impractical. For the purposes of this economic analysis, the years were grouped into three year types, based on water deliveries. Because economic impacts depend on water deliveries rather than hydrologic conditions, this grouping is a better basis for economic analysis than a grouping based on hydrologic conditions. The low-delivery years are the seven years of lowest water deliveries under a particular alternative. The high-delivery years are the 36 years with the highest water deliveries and the medium-delivery years are the remaining 30 years. The grouping is done independently for each alternative and each region. For example, the seven low-delivery years to Kern County under D-1485 are not the same years as the seven low-delivery years under any of the other alternatives. Water delivery impacts in each year type are the difference between deliveries under the alternative and deliveries under D-1485. Table XI-2 shows these water delivery impacts.

Figure XI -1
Map of Regions used in the Economic Analysis

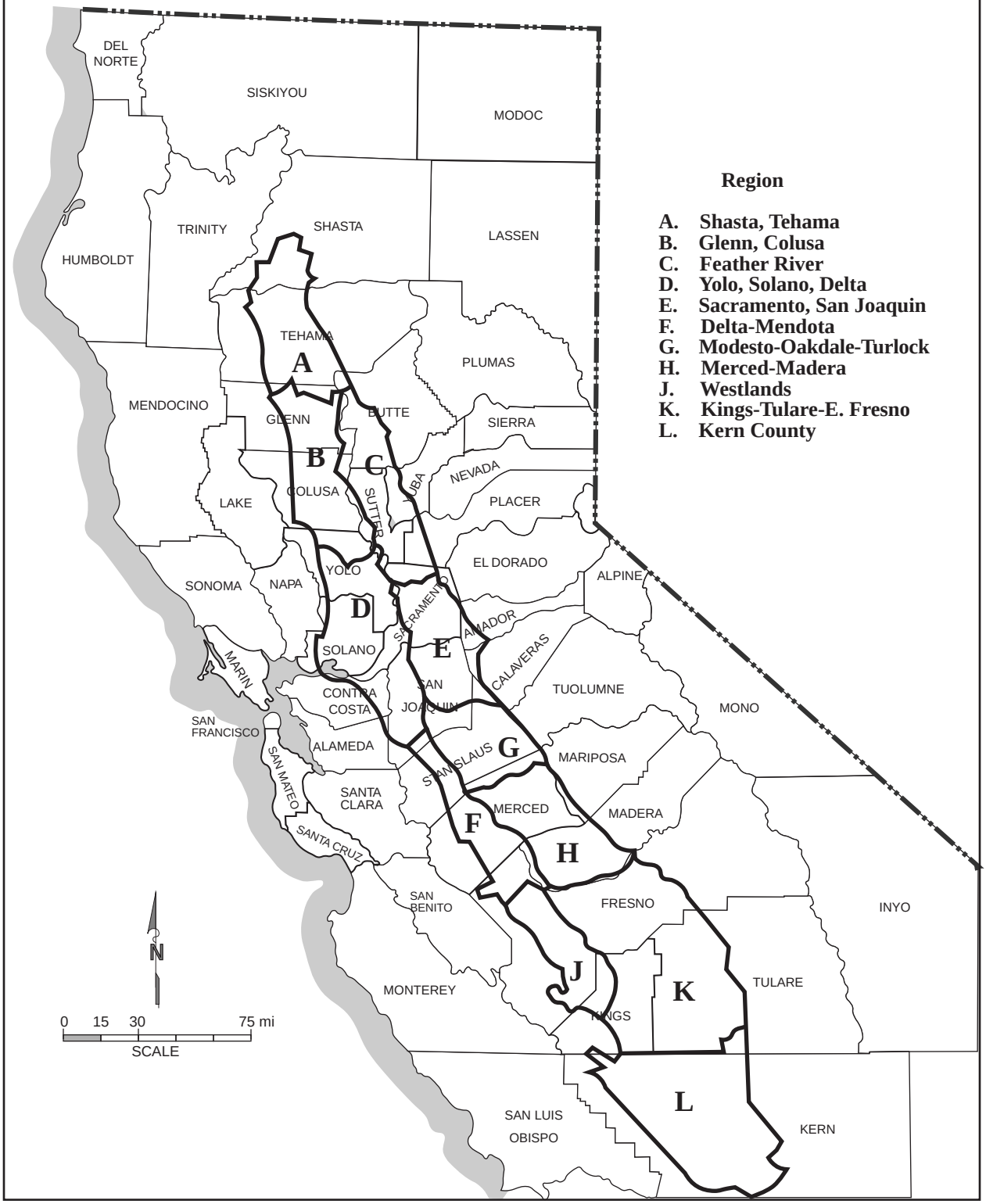


Table XI-2
Water Delivery Impacts of the Flow Alternatives as compared with the Base Case

(Water delivery impacts are shown only where an alternative affects deliveries to a region.)
(None of the alternatives affect deliveries to A or E.)

	Delivery impacts (k acre-ft)			
	Average all years	Low-delivery years	Medium delivery years	High-delivery years
B. **Glenn-Colusa (CVPM 3,4)**				
Alt. 5	-1	-15	0	0
C. **Feather River (CVPM 5,7)**				
Alt. 5	-100	-193	-95	-87
D. **Yolo-Solano-Delta (CVPM 6,9)**				
Alt. 5	14	4	23	8
F. **Delta-Mendota (CVPM 10)**				
Alt. 2	-69	-165	-79	-41
Alt. 3	-57	-140	-58	-41
Alt. 4	-58	-139	-60	-41
Alt. 5	-42	-80	-39	-37
Alt. 6	-48	-180	-62	-11
Alt. 7	-78	-184	-88	-49
Alt. 8	-80	-159	-90	-57
G. **Modesto-Oakdale-Turlock (CVPM 11, 12)**				
Alt. 3	-49	-84	-54	-39
Alt. 4	-50	-79	-54	-41
Alt. 5	-6	-67	0	0
Alt. 8	-31	-36	-29	-31
H. **Merced-Madera (CVPM 13)**				
Alt. 3	-32	-48	-40	-22
Alt. 4	-30	-44	-35	-23
Alt. 5	-18	-30	-17	-17
Alt. 8	-1	-6	0	0
J. **Westlands (CVPM 14)**				
Alt. 2	-94	-132	-106	-77
Alt. 3	-81	-109	-80	-76
Alt. 4	-81	-107	-81	-76
Alt. 5	-67	-63	-55	-78
Alt. 6	-51	-158	-63	-21
Alt. 7	-101	-144	-105	-89
Alt. 8	-117	-147	-118	-111
K. **Kings-Tulare-E. Fresno (CVPM 15-18)**				
Alt. 2	-6	-18	-11	0
Alt. 3	-5	-16	-9	0
Alt. 4	-5	-16	-9	0
Alt. 5	-425	-281	-336	-527
Alt. 6	-6	-19	-11	0
Alt. 7	-9	-18	-12	-4
Alt. 8	-6	-18	-11	0
L. **Kern County (CVPM 19-21)**				
Alt. 2	-58	-182	-81	-14
Alt. 3	-49	-168	-64	-13
Alt. 4	-49	-169	-64	-13
Alt. 5	-21	-80	-20	-10
Alt. 6	-52	-181	-78	-5
Alt. 7	-66	-172	-99	-17
Alt. 8	-61	-175	-85	-18
All regions				
Alt. 2	-227	-497	-277	-132
Alt. 3	-274	-565	-305	-191
Alt. 4	-273	-554	-303	-194
Alt. 5	-668	-805	-539	-748
Alt. 6	-158	-538	-214	-37
Alt. 7	-253	-518	-304	-159
Alt. 8	-296	-541	-333	-217

2. Assumptions and Methodology

The effect of each alternative on producers' net income was estimated by applying water delivery impacts to a relationship between water supplies and net revenues in each region established using the Central Valley Production Model (CVPM). The CVPM, developed by the University of California, the DWR and the USBR, is a mathematical programming model that estimates crop production. The model is based on the assumption that farmers select the cropping pattern that maximizes their net revenue given product prices, production costs, and the availability of inputs such as land and water.

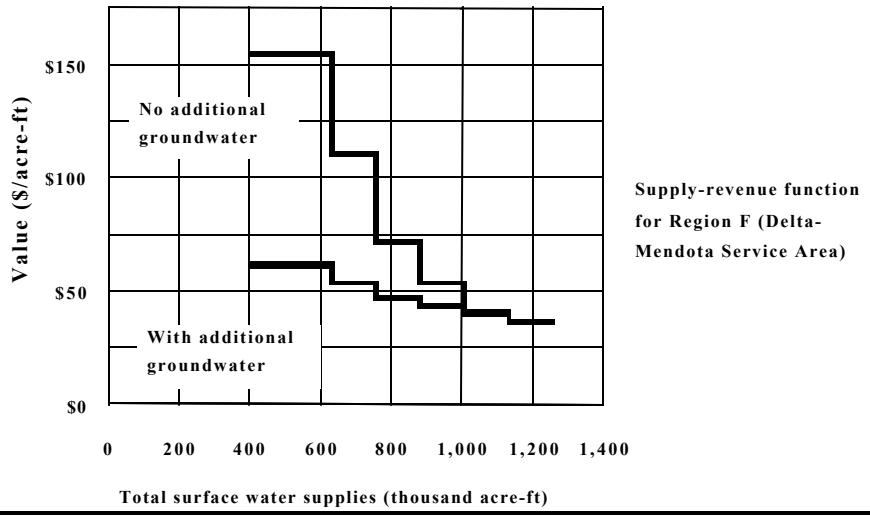
The CVPM assumes that farmers continually adjust production levels in an effort to maximize their returns on investment. In practice, farmers' flexibility is limited in the short run. Consequently, production levels indicated by the model are a long-run response to changing conditions. As used in this analysis, the model implicitly assumes that farmers adjust their production levels to average water supplies in the three year types. However, water supplies vary from year to year, so there will not actually be a movement toward the production levels that are optimum for supplies in the three year types. The actual long-run response to the standards will be an adjustment to lower, but variable, water availability. As a result, the model will tend to underestimate economic impacts because a complete long-run response to average supplies in each year type is never achieved.

Staff of CH2M Hill used the model to estimate the way revenues in each region fall as surface water supplies are reduced from the amount normally available in wet years. One set of model runs gives economic impacts in the case where farmers increase their use of groundwater as surface supplies are reduced. A second set of runs gives economic impacts in the case where no additional groundwater is available (Hatchett 1997).

These model runs established a supply-revenue function for each region showing the value of an acre-foot of water at various levels of water supply. This value is the amount by which net revenues in the region will increase or decrease as surface water supplies increase or decrease by one acre-foot. When full surface water supplies are available, the value of an acre-foot of water is relatively low, because the water is used on a wide variety of crops, including low-valued crops. But in years when surface water supplies are low, the value of an acre-foot of water is higher, because a greater proportion of the water is used on high-valued crops.

As an example, Figure XI-2 shows the supply-revenue function for Region F. When the region receives its full surface water supply of about 1.2 million acre-feet, reducing surface water supplies by an incremental amount reduces net revenues in the region by about $37 per acre-foot of reduced deliveries. In years when the region receives only 700 TAF, a further cutback by an incremental amount reduces net revenues by about $54 per acre-foot of reduced deliveries if farmers are able to use additional groundwater, or by $111 per acre-foot of reduced deliveries if no additional groundwater is available.

Figure XI-2. Value of Water at Various Levels of Water Supply



Water supply data compiled for the economic analysis in the ER for the 1995 Bay/Delta Plan was used to estimate average surface water supplies in each region in each of the three year types under D-1485 (Dale 1994). This information determines the point on the supply-revenue function that each region is in each of the three year types under baseline conditions. Impacts of each alternative on net revenues were then estimated from the water supply impacts shown in Table XI-2 using the supply-revenue functions for each region.

3. Results

Tables XI-3 and XI-4 show the effects of the flow alternatives on producers' net revenue and agricultural production. When totaled over all regions, Alternatives 2, 3, 4, and 7 have about the same effect on net income. In these alternatives, losses range from $20 to $25 million. Alternative 8 has slightly higher impacts, averaging $25 to $27 million annually, depending on whether additional groundwater is available. In dry years, losses are substantially higher and are more dependent on the availability of additional groundwater. In the seven low-delivery years, losses for the alternatives range from $50 to $58 million when additional groundwater is available, but range from $68 to $73 million if no additional groundwater is available.

Compared to Alternative 2, Alternatives 3 and 4 have less impact in the east side of the San Joaquin Valley (Regions G and H) and more impact in the Delta-Mendota area (Region F), the Westlands area (Region J), and Kern County (Region L).

Alternative 6 has higher impacts than Alternatives 2, 3, and 4, in low-delivery years. However, impacts are lower when averaged over all years, largely because Alternative 6 has very low impacts in high-delivery years. Alternative 5 has high impacts in all year types, largely because it results in higher Delta outflows than the other alternatives. In dry years, impacts are about the same as the other alternatives. However, in contrast to the other alternatives, Alternative 5 has high impacts in

Table XI-3
Impacts of Flow Alternatives on Producers' Net Income as Compared to the Base Case

	Loss in net revenue ($Million)							
	Additional groundwater use				No additional groundwater			
	Average all years	Low-delivery years	Medium delivery years	High-delivery years	Average all years	Low-delivery years	Medium delivery years	High-delivery years
B. **Glenn-Colusa (CVPM 3,4)**								
Alt. 5	0.1	0.6	0	0	0.1	0.6	0	0
C. **Feather River (CVPM 5,7)**								
Alt. 5	3.8	7.5	3.6	3.3	3.8	7.7	3.6	3.3
D. **Yolo-Solano-Delta (CVPM 6,9)**								
Alt. 5	-0.6	-0.2	-1.0	-0.3	-0.6	-0.2	-1.0	-0.3
F. **Delta-Mendota (CVPM 10)**								
Alt. 2	2.7	7.4	3.0	1.5	2.9	10.1	3.0	1.5
Alt. 3	2.2	6.2	2.2	1.5	2.4	8.3	2.2	1.5
Alt. 4	2.2	6.2	2.2	1.5	2.5	8.2	2.3	1.5
Alt. 5	1.6	3.5	1.4	1.4	1.7	4.3	1.4	1.4
Alt. 6	1.9	8.1	2.3	0.4	2.2	11.1	2.3	0.4
Alt. 7	3.1	8.3	3.4	1.8	3.4	11.4	3.4	1.8
Alt. 8	3.2	7.1	3.5	2.1	3.4	9.6	3.5	2.1
G. **Modesto-Oakdale-Turlock (CVPM 11,12)**								
Alt. 3	2.1	3.9	2.2	1.6	2.1	4.0	2.2	1.6
Alt. 4	2.1	3.7	2.2	1.7	2.1	3.8	2.2	1.7
Alt. 5	0.3	3.1	0	0	0.3	3.2	0	0
Alt. 8	1.3	1.7	1.2	1.3	1.3	1.7	1.2	1.3
H. **Merced-Madera (CVPM 13)**								
Alt. 3	1.7	2.8	2.1	1.1	1.7	3.3	2.1	1.1
Alt. 4	1.6	2.6	1.8	1.2	1.7	3.0	1.9	1.2
Alt. 5	1.0	1.7	0.9	0.9	1.0	2.0	0.9	0.9
Alt. 8	0.0	0.3	0	0	0.0	0.4	0	0
J. **Westlands (CVPM 14)**								
Alt. 2	10.3	16.3	11.4	8.3	10.6	18.8	11.4	8.3
Alt. 3	8.9	13.3	8.6	8.2	9.0	15.0	8.6	8.2
Alt. 4	8.9	13.0	8.7	8.2	9.0	14.7	8.7	8.2
Alt. 5	7.3	7.5	5.9	8.4	7.4	8.4	5.9	8.4
Alt. 6	5.8	19.8	6.8	2.3	6.1	23.0	6.8	2.3
Alt. 7	11.1	17.9	11.3	9.6	11.4	20.8	11.3	9.6
Alt. 8	12.9	18.4	12.7	11.9	13.1	21.2	12.7	11.9
K. **Kings-Tulare-E. Fresno (CVPM 15-18)**								
Alt.2	0.5	1.4	0.8	0	0.5	1.7	0.8	0
Alt.3	0.4	1.2	0.6	0	0.4	1.5	0.6	0
Alt.4	0.4	1.2	0.6	0	0.4	1.5	0.6	0
Alt.5	28.3	22.7	23.3	33.6	29.8	29.7	25.2	33.6
Alt.6	0.5	1.4	0.8	0	0.5	1.8	0.8	0
Alt.7	0.6	1.4	0.8	0.3	0.7	1.7	0.9	0.3
Alt.8	0.5	1.4	0.8	0	0.5	1.7	0.8	0
L. **Kern County (CVPM 19-21)**								
Alt.2	6.7	25.4	8.8	1.3	8.6	39.7	10.2	1.3
Alt.3	5.7	23.5	7.0	1.2	7.4	36.6	8.0	1.2
Alt.4	5.7	23.6	7.0	1.2	7.4	36.9	8.0	1.2
Alt.5	2.4	11.2	2.1	1.0	3.1	17.4	2.3	1.0
Alt.6	6.2	25.3	8.5	0.5	8.1	39.5	9.8	0.5
Alt.7	7.5	24.0	10.8	1.6	9.5	37.5	12.5	1.6
Alt.8	7.0	24.5	9.3	1.7	8.9	38.2	10.7	1.7
All regions								
Alt.2	20.2	50.5	24.0	11.1	22.7	70.3	25.4	11.1
Alt.3	20.9	50.9	22.7	13.6	23.0	68.7	23.7	13.6
Alt.4	20.9	50.3	22.5	13.8	23.1	68.1	23.7	13.8
Alt.5	44.2	57.6	36.2	48.3	46.6	73.1	38.3	48.3
Alt.6	14.4	54.6	18.4	3.2	16.9	75.4	19.7	3.2
Alt.7	22.3	51.6	26.3	13.3	25.0	71.4	28.1	13.3
Alt.8	24.8	53.4	27.5	17.0	27.2	72.8	28.9	17.0

Impacts are shown only where alternative affects a region.

Table XI-4
Impacts of Flow Alternatives on Farm Production as Compared to the Base Case

	Loss in farm production ($Million)							
	Additional groundwater use				No additional groundwater			
	Average all years	Low-delivery years	Medium delivery years	High-delivery years	Average all years	Low-delivery years	Medium delivery years	High-delivery years
B. **Glenn-Colusa (CVPM 3,4)**								
Alt. 5	0	2	0	0	0	2	0	0
C. **Feather River (CVPM 5,7)**								
Alt. 5	12	23	11	10	12	24	11	10
D. **Yolo-Solano-Delta (CVPM 6,9)**								
Alt. 5	-2	-1	-3	-1	-2	-1	-3	-1
F. **Delta-Mendota (CVPM 10)**								
Alt. 2	7	19	8	4	8	26	8	4
Alt. 3	6	16	6	4	6	21	6	4
Alt. 4	6	16	6	4	6	21	6	4
Alt. 5	4	9	4	4	5	11	4	4
Alt. 6	5	21	6	1	6	28	6	1
Alt. 7	8	21	6	1	6	28	6	1
Alt. 8	8	18	9	5	9	25	9	5
G. **Modesto-Oakdale-Turlock (CVPM 11,12)**								
Alt. 3	4	8	5	3	4	8	5	3
Alt. 4	5	8	5	4	5	8	5	4
Alt. 5	1	6	0	0	1	7	0	0
Alt. 8	3	4	3	3	3	4	3	3
H. **Merced-Madera (CVPM 13)**								
Alt. 3	3	6	4	2	3	7	4	2
Alt. 4	3	5	4	2	3	6	4	2
Alt. 5	2	3	2	2	2	4	2	2
Alt. 8	0	1	0	0	0	1	0	0
J. **Westlands (CVPM 14)**								
Alt. 2	25	40	27	20	25	46	27	20
Alt. 3	21	32	20	20	22	37	20	20
Alt. 4	22	32	21	20	22	36	21	20
Alt. 5	17	18	14	20	18	20	14	20
Alt. 6	14	48	16	5	14	56	16	5
Alt. 7	27	44	27	23	27	51	27	23
Alt. 8	30	45	30	28	31	52	30	28
K. **Kings-Tulare-E. Fresno (CVPM 15-18)**								
Alt.2	1	3	2	0	1	3	2	0
Alt.3	1	2	1	0	1	3	1	0
Alt.4	1	2	1	0	1	3	1	0
Alt.5	53	43	44	63	56	56	48	63
Alt.6	1	3	2	0	1	3	2	0
Alt.7	2	3	2	1	2	3	2	1
Alt.8	1	3	2	0	1	3	2	0
L. **Kern County (CVPM 19-21)**								
Alt.2	14	51	18	3	17	79	20	3
Alt.3	11	47	14	2	15	73	16	2
Alt.4	11	47	14	2	15	74	16	2
Alt.5	5	22	4	2	6	35	5	2
Alt.6	12	51	17	1	16	79	20	1
Alt.7	15	48	22	3	19	75	25	3
Alt.8	14	49	19	3	17	76	21	3
All regions								
Alt.2	47	113	55	27	52	154	57	27
Alt.3	46	111	50	31	51	149	52	31
Alt.4	47	110	51	32	52	148	53	32
Alt.5	93	125	76	100	98	158	81	100
Alt.6	32	123	41	7	37	166	44	7
Alt.7	52	116	60	32	57	158	63	32
Alt.8	57	120	63	39	61	161	65	39

Impacts are shown only where alternative affects a region.

medium-delivery and high-delivery years. In these years, impacts range from $36 to $48 million. Averaged over all years, the impacts of Alternative 5 are $44 to $47 million, substantially higher than any of the other alternatives.

Alternative 5 affects water use in the Feather River Basin (Region C). Depending on the year type and the availability of additional groundwater, net revenues are reduced by $3 to $8 million annually. Alternative 5 has very high impacts on the Kings-Tulare-East Fresno area (Region K), reducing net revenues by up to $34 million. In this area, the highest impacts are in high-delivery years. Alternative 5 increases impacts in the Merced-Madera area (Region H) and reduces impacts in Kern County relative to Alternative 2.

In addition to the costs cited above, farmers in the Sacramento Valley will have to pay the USBR for contracted water to replace water that is no longer available for diversion under appropriative water rights. The cost and amount of this water will be a contract issue between the USBR and the contractors.

Impacts on farm production (see Table XI-4) are approximately proportional to impacts on net revenues. In total, Alternatives 2, 3, 4, and 7 reduce farm production by about $50 million when averaged over all years. In dry years, impacts are about $100 million when additional groundwater is used and about $150 million when no additional groundwater is available. Alternative 8 has slightly higher impacts than these alternatives. Generally, impacts on farm production vary between alternatives and between regions in the same way as impacts on net revenues.

These impacts are comparable to recent fluctuations in crop production in the affected areas. Table XI-5 shows recent county crop production statistics from the California Department of Food and Agriculture. In Kern county, crop production ranged from $1,400 million to $1,800 million between 1990 and 1995. In comparison, impacts of the alternatives range up to $79 million in dry years and are $5 to $19 million when averaged over all years. As a percentage of average crop production from 1990 to 1995, impacts do not exceed five percent in dry years or one percent when averaged over all years.

Table XI-5
Recent Crop Production in Affected Areas

Counties	Crop production ($ million)					
	1990	1991	1992	1993	1994	1995
Fresno-Kings-Tulare	4,170	3,510	3,940	4,380	4,520	4,750
Kern	1,710	1,420	1,430	1,760	1,820	1,770
Nevada-Placer-Sutter-Yuba	300	380	400	410	480	460
Stanislaus-Merced-Madera	1,430	1,370	1,550	1,770	1,710	1,630

The other regions do not correspond closely to counties, but rough comparisons can be made between totals for Kings, Tulare, and Fresno counties with impacts in Regions J and K. Impacts in this area do not exceed two percent of crop production under Alternative 5 and are less than one percent of crop production under the other alternatives. Similarly, totals for, Nevada, Placer,

Sutter, and Yuba counties can be compared with impacts in Region C. Under Alternative 5, impacts are six percent of crop production in dry years and about three percent of crop production averaged over all year types.

B. IMPACTS ON URBAN WATER USERS

The alternatives will affect deliveries of SWP and CVP water to water wholesaling agencies and diversions of water from the Mokelumne River by EBMUD. The water deliveries affected will be SWP deliveries to the Metropolitan Water District of Southern California (MWD) and other southern California water agencies and SWP and CVP deliveries to the Santa Clara Valley Water District (SCVWD). Opportunities for developing new water supplies are very limited. Consequently, these agencies and retail water utilities that they serve are likely to respond by arranging transfers of water from agricultural users, increasing use of recycled water, reducing water use by more extensive conservation programs, and possibly imposing rationing on their customers.

1. Methodology

Economic impacts on urban water users were estimated assuming that the only options available to water utilities are additional water transfers and rationing. Water utilities might also reclaim water or reduce demand through water conservation programs. To the extent possible, wholesaling agencies and water utilities will try to avoid rationing by arranging water transfers, since the cost of transferred water is far lower than the shortage costs resulting from water rationing. However, transfers are limited by the factors discussed in Chapter V. Economic impacts of two scenarios are estimated. In one scenario, the entire reduction in water project deliveries is assumed replaced by water transfers. The value of the impacts is estimated as the cost of the replacement water. In a second scenario, it is assumed that no additional water transfers can be made so that reduced deliveries result in water rationing. The value of impacts is estimated as the shortage costs resulting from this rationing. Shortage costs represent the value lost to consumers as a result of reducing water use below desired levels, rather than out-of pocket expenses for increased water bills. Shortage costs are a measure of the cost and inconvenience to consumers of reducing water use in response to rationing and price increases.

The impacts of each alternative were estimated using results developed for the economic analysis in the ER for the 1995 Bay/Delta Plan. The water utilities' forecasting models were used to estimate the economic impacts of reductions in water project deliveries under two alternatives under consideration by the SWRCB in 1994.

Estimates of the cost per acre-foot of replacement water used in these model runs were developed in consultation with planning staff of the MWD and the SCVWD. The cost of transfers to the MWD was estimated as $200 per acre-foot, and the cost of transfers to the SCVWD was estimated as ranging from $250 to $350 per acre-foot. The MWD's transfer cost was used as an estimate of the cost of transfers to southern California water agencies and the SCVWD's transfer cost was used as an estimate of EBMUD's transfer cost.

Shortage costs were based on a cost function developed by Larry Dale Associates (Dale 1994). The function is as follows: for shortages of up to 10 percent, shortage costs are $1,400 per acre-foot; for shortages of 10 to 20 percent, shortage costs are $1,700 per acre-foot; and for shortages over 20 percent, shortage costs are $2,000 per acre-foot.

These model results were used to establish a relationship between reductions in project deliveries and economic impacts. This relationship was applied to the delivery impacts of each alternative to estimate the impacts of the reductions in project deliveries in the alternatives.

2. Results

Under the transfer scenario, the total cost of transferred water to all affected agencies ranges from an average of $12 million in Alternative 5 to $17 million in Alternative 7. Costs are higher in dry years, ranging from $31 million in Alternative 7 to $41 million under Alternative 5. The alternatives affect each water agency differently. Alternatives 2, 3, 4, 6, 7, and 8 most affect MWD, the other southern California SWP contractors, and SCVWD. Alternative 5 reduces costs to the SWP contractors and SCVWD, but increases costs to EBMUD. Details are shown Table XI-6.

Because water agencies have good access to credit and can borrow to cover high costs occurring in dry years, the average costs over all years are the relevant measure of their costs. The costs of transfers do not increase these agencies' costs appreciably. For example, under Alternative 2, the average cost of transferred water to the MWD and the other southern California SWP contractors is $13 million. This cost is about four tenths of one percent of the total retail cost of water delivered to urban users in southern California.

For several reasons, water agencies may be unable to replace all water lost from reduced deliveries by transfers. In dry years, transfers must be arranged at short notice. The cost of arranging transfers may be significant and there may be legal restrictions on transfers. Under the second scenario with no additional transfers, shortage costs in all agencies' service areas range from $197 to $225 million in low-delivery years. These costs are additional to shortage costs occurring under baseline conditions. Over all years, shortage costs average $73 to $114 million annually. Shortage costs vary between alternatives in the same way as transfer costs do.

C. REGIONAL ECONOMIC IMPACTS

Reductions in water deliveries to agricultural users will affect all sectors of the economy. When farm production falls as a result of reduced water availability, farmers will hire fewer seasonal workers and may lay off some year-round workers. Until they find other jobs, consumer spending by these workers is likely to fall, affecting retailers and other businesses in the area. In addition, farmers will reduce purchases of equipment, materials, and services from local businesses, reducing jobs and income with these suppliers.

Table XI-6
Impacts of Flow Alternatives on Urban Water Users as Compared to the Base Case

	Average all years			Low-delivery years		
	Delivery impacts (k acre-ft)	Cost of transfers ($ million)	Shortage costs if no transfers	Delivery impacts (k acre-ft)	Cost of transfers ($ million)	Shortage costs if no transfers
East Bay MUD						
Alt.3	-3	1	5	-4	1	7
Alt.4	-3	1	5	-5	2	9
Alt.5	-22	6	32	-79	28	138
SWP & CVP deliveries to SCVWD						
Alt.2	-8	2	12	-24	8	42
Alt.3	-7	2	10	-23	8	40
Alt.4	-7	2	10	-23	8	40
Alt.5	-3	1	4	-12	4	21
Alt.6	-8	2	12	-23	8	40
Alt.7	-9	2	14	-24	8	42
Alt.8	-9	2	12	-24	8	42
SWP deliveries to MWD						
Alt.2	-46	9	64	-65	13	91
Alt.3	-40	8	56	-55	11	77
Alt.4	-40	8	57	-57	11	80
Alt.5	-21	4	29	-18	4	25
Alt.6	-42	8	59	-63	13	88
Alt.7	-46	9	64	-48	10	67
Alt.8	-41	8	58	-59	12	83
SWP deliveries to Southern Cal						
Alt.2	-22	4	30	-66	13	92
Alt.3	-17	3	24	-62	12	87
Alt.4	-18	4	25	-63	13	88
Alt.5	-6	1	8	-29	6	41
Alt.6	-21	4	29	-64	13	90
Alt.7	-25	5	36	-63	13	88
Alt.8	-22	4	31	-61	12	85
All agencies						
Alt.2	-75	15	106	-155	35	225
Alt.3	-68	14	95	-144	33	211
Alt.4	-68	14	96	-148	34	217
Alt.5	-51	12	73	-138	41	225
Alt.6	-71	15	100	-150	33	218
Alt.7	-81	17	114	-135	31	197
Alt.8	-72	15	101	-144	32	210

Job and income losses resulting from the alternatives were estimated using input-output analysis, a widely-used economic technique. The procedure is described in section D.2 of this chapter. Input-

output analysis usually overestimates indirect job and income losses. One of the fundamental assumptions in input-output analysis is that trading patterns between industries are fixed. This assumption implies that suppliers always cut production and lay off workers in proportion to the amount of product supplied to farms or other industries reducing production. In reality, businesses are always adapting to changing conditions. When a farm cuts back production, some suppliers will be able to make up part of their losses in business by finding new markets in other areas. Growth in other parts of the local economy will often provide opportunities for these firms. For these and other reasons, job and income losses estimated using input-output analysis should be treated as upper limits on the actual losses expected.

1. Job and Income Impacts

Impacts of the flow alternatives on jobs are shown in Tables XI-7 and XI-8. The total number of jobs displaced in the agricultural sector ranges from 370 to 1,130 when averaged over all year types. Impacts are somewhat higher if no additional groundwater can be used. Job impacts vary between alternatives and year types in the same way impacts on producers' income do. Job impacts are highest under Alternative 5 and, when averaged over all years, and lowest under Alternative 6. It should be emphasized that these displaced jobs do not represent a permanent job loss to a region. Regional job markets are affected by growth in all sectors of the economy and migration to and from the area. Moreover, the agricultural labor force is very mobile with a high proportion of seasonal workers. A job displacement in agriculture is likely to result in a slight decrease in net migration into the area and a change in seasonal movements of workers. As a result, the effect of implementing the objectives on the number of unemployed farm workers in an area will be smaller than the job displacement indicated by this analysis, and will gradually decline as migration patterns change and the rest of the economy grows.

Job displacements in other sectors of the economy, when averaged over all year types, range from about 500 under Alternative 6 to 1,500 under Alternative 5 when additional groundwater is used. In low-delivery years, indirect job displacements range from about 1,800 to 2,000 if additional groundwater is used and from about 2,400 to 2,700 if no additional groundwater is available.

Income losses also give an indication of the extent of impacts on a region's economy. Income losses (see Table XI-9) are estimated using input-output analysis and like the estimates of employment impacts, should be treated as upper limits. Income losses as estimated by input-output analysis will occur only if displaced workers are unable to find other jobs and businesses supplying farms and their employees have very limited ability to find new markets.

Although these job and income losses will cause individual hardship, they are small in comparison to total employment and income in the affected areas. Table XI-10 shows total employment and

Table XI-7
Impacts of Flow Alternatives on Farm Employment as Compared to the Base Case

	Direct job displacement							
	Additional groundwater use				No additional groundwater			
	Average all years	Low-delivery years	Medium delivery years	High-delivery years	Average all years	Low-delivery years	Medium delivery years	High-delivery years
B. **Glenn-Colusa (CVPM 3,4)**								
Alt. 5	0	20	0	0	0	20	0	0
C. **Feather River (CVPM 5,7)**								
Alt. 5	140	270	130	120	140	280	130	120
D. **Yolo-Solano-Delta (CVPM 6,9)**								
Alt. 5	-20	-10	-30	-10	-20	-10	-30	-10
F. **Delta-Mendota (CVPM 10)**								
Alt. 2	80	220	90	50	90	300	90	50
Alt. 3	70	180	70	50	80	240	70	50
Alt. 4	70	180	70	50	80	240	70	50
Alt. 5	50	100	50	50	60	130	50	50
Alt. 6	60	240	70	10	60	320	70	10
Alt. 7	90	240	100	60	100	330	100	60
Alt. 8	90	210	100	60	100	290	100	60
G. **Modesto-Oakdale-Turlock (CVPM 11,12)**								
Alt. 3	50	90	60	30	50	90	60	30
Alt. 4	60	90	60	50	60	90	60	50
Alt. 5	10	70	0	0	10	80	0	0
Alt. 8	30	50	30	30	30	50	30	30
H. **Merced-Madera (CVPM 13)**								
Alt. 3	40	70	50	20	40	80	50	20
Alt. 4	40	60	50	20	40	70	50	20
Alt. 5	20	30	20	20	20	50	20	20
Alt. 8	0	10	0	0	0	10	0	0
J. **Westlands (CVPM 14)**								
Alt. 2	280	460	310	230	290	530	310	230
Alt. 3	240	370	230	230	250	430	230	230
Alt. 4	250	370	240	230	250	420	240	230
Alt. 5	200	210	160	230	200	230	160	230
Alt. 6	160	550	180	60	170	650	180	60
Alt. 7	310	510	310	270	320	590	310	270
Alt. 8	350	520	350	320	360	600	350	320
K. **Kings-Tulare-E. Fresno (CVPM 15-18)**								
Alt.2	10	30	20	0	10	30	20	0
Alt.3	10	20	10	0	10	30	10	0
Alt.4	10	20	10	0	10	30	10	0
Alt.5	620	500	510	730	650	650	550	730
Alt.6	10	30	20	0	10	30	20	0
Alt.7	20	30	20	10	20	30	20	10
Alt.8	10	30	20	0	10	30	20	0
L. **Kern County (CVPM 19-21)**								
Alt.2	160	590	210	30	200	910	230	30
Alt.3	130	540	160	20	160	840	180	20
Alt.4	130	540	160	20	170	850	180	20
Alt.5	50	250	50	20	70	400	60	20
Alt.6	140	590	200	10	190	910	230	10
Alt.7	170	550	250	30	220	870	290	30
Alt.8	160	570	220	30	200	880	240	30
All regions								
Alt.2	530	1,300	630	310	590	1,770	650	310
Alt.3	540	1,270	580	350	590	1,710	600	350
Alt.4	560	1,260	590	370	610	1,700	610	370
Alt.5	1,070	1,440	890	1,160	1,130	1,830	940	1,160
Alt.6	370	1,410	470	80	430	1,910	500	80
Alt.7	590	1,330	680	370	660	1,820	720	370
Alt.8	640	1,390	720	440	700	1,860	740	440

Impacts are shown only where alternative affects a region.

Table XI-8
Impacts of Flow Alternatives on Employment in Other Industries as Compared to the Base Case

	Indirect job displacement							
	Additional groundwater use				No additional groundwater			
	Average all years	Low-delivery years	Medium delivery years	High-delivery years	Average all years	Low-delivery years	Medium delivery years	High-delivery years
B. **Glenn-Colusa (CVPM 3,4)**								
Alt. 5	0	30	0	0	0	30	0	0
C. **Feather River (CVPM 5,7)**								
Alt. 5	190	380	180	170	200	390	180	170
D. **Yolo-Solano-Delta (CVPM 6,9)**								
Alt. 5	-20	-10	-40	-10	-20	-10	-40	-10
F. **Delta-Mendota (CVPM 10)**								
Alt. 2	120	310	130	70	130	420	130	70
Alt. 3	100	250	100	70	110	340	100	70
Alt. 4	100	250	100	70	110	340	100	70
Alt. 5	80	140	70	70	80	180	70	70
Alt. 6	80	340	100	10	90	450	100	10
Alt. 7	130	340	140	80	140	460	140	80
Alt. 8	120	290	140	80	140	410	140	80
G. **Modesto-Oakdale-Turlock (CVPM 11,12)**								
Alt. 3	70	130	80	40	70	130	80	40
Alt. 4	80	130	80	70	80	130	80	70
Alt. 5	10	100	0	0	10	110	0	0
Alt. 8	40	70	40	40	40	70	40	40
H. **Merced-Madera (CVPM 13)**								
Alt. 3	50	100	70	30	50	110	70	30
Alt. 4	50	80	70	30	50	100	70	30
Alt. 5	30	40	30	30	30	70	30	30
Alt. 8	0	10	0	0	0	10	0	0
J. **Westlands (CVPM 14)**								
Alt. 2	400	640	430	320	410	740	430	320
Alt. 3	340	520	320	320	350	600	320	320
Alt. 4	350	520	340	320	350	590	340	320
Alt. 5	280	290	220	320	280	320	220	320
Alt. 6	220	770	250	80	230	910	250	80
Alt. 7	430	710	430	380	440	830	430	380
Alt. 8	490	730	490	450	500	840	490	450
K. **Kings-Tulare-E. Fresno (CVPM 15-18)**								
Alt.2	20	40	30	0	20	40	30	0
Alt.3	10	30	10	0	10	40	10	0
Alt.4	10	30	10	0	10	40	10	0
Alt.5	860	700	710	1,020	910	910	770	1,020
Alt.6	20	40	30	0	20	40	30	0
Alt.7	20	40	30	10	20	40	30	10
Alt.8	20	40	30	0	20	40	30	0
L. **Kern County (CVPM 19-21)**								
Alt.2	220	830	290	40	270	1,270	320	40
Alt.3	180	760	220	30	230	1,180	250	30
Alt.4	180	760	220	30	230	1,190	250	30
Alt.5	80	350	70	30	100	560	80	30
Alt.6	200	830	280	10	260	1,270	320	10
Alt.7	240	770	350	40	310	1,220	410	40
Alt.8	220	800	310	40	280	1,230	340	40
All regions								
Alt.2	760	1,820	880	430	830	2,470	910	430
Alt.3	750	1,790	800	490	820	2,400	830	490
Alt.4	770	1,770	820	520	830	2,390	850	520
Alt.5	1,510	2,020	1,240	1,630	1,590	2,560	1,310	1,630
Alt.6	520	1,980	660	100	600	2,670	700	100
Alt.7	820	1,860	950	510	910	2,550	1,010	510
Alt.8	890	1,940	1,010	610	980	2,600	1,040	610

Impacts are shown only where alternative affects a region.

Table XI-9
Impacts of Flow Alternatives on Regional Income as Compared to the Base Case

	Loss in personal income ($Million)							
	Additional groundwater use				No additional groundwater			
	Average all years	Low-delivery years	Medium delivery years	High-delivery years	Average all years	Low-delivery years	Medium delivery years	High-delivery years
B. **Glenn-Colusa (CVPM 3,4)**								
Alt. 5	0	1	0	0	0	1	0	0
C. **Feather River (CVPM 5,7)**								
Alt. 5	7	14	7	6	7	14	7	6
D. **Yolo-Solano-Delta (CVPM 6,9)**								
Alt. 5	-1	-1	-2	-1	-1	-1	-2	-1
F. **Delta-Mendota (CVPM 10)**								
Alt. 2	4	11	5	2	5	15	5	2
Alt. 3	4	10	4	2	4	12	4	2
Alt. 4	4	10	4	2	4	12	4	2
Alt. 5	3	5	2	2	3	7	2	2
Alt. 6	3	12	4	1	3	17	4	1
Alt. 7	5	12	5	3	5	17	5	3
Alt. 8	5	11	5	3	5	15	5	3
G. **Modesto-Oakdale-Turlock (CVPM 11,12)**								
Alt. 3	3	5	3	2	3	5	3	2
Alt. 4	3	5	3	2	3	5	3	2
Alt. 5	0	4	0	0	0	4	0	0
Alt. 8	2	2	2	2	2	2	2	2
H. **Merced-Madera (CVPM 13)**								
Alt. 3	2	4	2	1	2	4	2	1
Alt. 4	2	3	2	1	2	4	2	1
Alt. 5	1	2	1	1	1	2	1	1
Alt. 8	0	1	0	0	0	1	0	0
J. **Westlands (CVPM 14)**								
Alt. 2	15	24	16	12	15	27	16	12
Alt. 3	13	19	12	12	13	22	12	12
Alt. 4	13	19	12	12	13	21	12	12
Alt. 5	10	11	8	12	10	12	8	12
Alt. 6	8	29	10	3	9	33	10	3
Alt. 7	16	26	16	14	16	30	16	14
Alt. 8	18	27	18	17	18	31	18	17
K. **Kings-Tulare-E. Fresno (CVPM 15-18)**								
Alt.2	1	2	1	0	1	2	1	0
Alt.3	0	1	1	0	0	2	1	0
Alt.4	0	1	1	0	0	2	1	0
Alt.5	32	26	26	37	33	33	29	37
Alt.6	1	2	1	0	1	2	1	0
Alt.7	1	2	1	1	1	2	1	1
Alt.8	1	2	1	0	1	2	1	0
L. **Kern County (CVPM 19-21)**								
Alt.2	8	30	11	2	10	47	12	2
Alt.3	7	28	8	1	9	43	10	1
Alt.4	7	28	8	1	9	44	10	1
Alt.5	3	13	2	1	4	21	3	1
Alt.6	7	30	10	1	10	47	12	1
Alt.7	9	29	13	2	11	45	15	2
Alt.8	8	29	11	2	10	45	12	2
All regions								
Alt.2	28	67	33	16	31	91	34	16
Alt.3	28	66	30	18	30	89	31	18
Alt.4	28	65	30	19	31	88	31	19
Alt.5	55	74	45	59	58	94	48	59
Alt.6	19	73	24	4	22	99	26	4
Alt.7	31	69	36	19	34	94	37	19
Alt.8	34	71	37	23	36	96	39	23

Impacts are shown only where alternative affects a region.

Table XI-10
Employment and Income in the Affected Areas

	1990	1991	1992	1993	1994
Farm employment					
Fresno-Kings-Tulare	53,000	53,000	48,000	53,000	51,000
Kern	14,000	15,000	14,000	17,000	17,000
Nevada-Placer-Sutter-Yuba	8,000	8,000	7,000	7,000	7,000
Stanislaus-Merced-Madera	27,000	28,000	27,000	27,000	27,000
Nonfarm employment					
Fresno-Kings Tulare	478,000	475,000	481,000	492,000	506,000
Kern	243,000	248,000	243,000	241,000	245,000
Nevada-Placer-Sutter-Yuba	174,000	180,000	181,000	182,000	188,000
Stanislaus-Merced-Madera	259,000	260,000	260,000	262,000	265,000
Total personal income ($M)					
Fresno-Kings-Tulare	16,700	17,100	18,400	19,200	19,600
Kern	8,600	9,000	9,400	9,800	10,100
Nevada-Placer-Sutter-Yuba	6,900	7,500	8,000	8,300	8,800
Stanislaus-Merced-Madera	10,000	10,200	10,900	11,300	11,700

income for groups of counties roughly corresponding to the regions most affected by the alternatives. These figures show that the impacts of the alternatives are too small to have any significant region-wide effects.

2. Details of Estimation Methods

Wage losses in agriculture were estimated from changes in agricultural production using a ratio of labor costs to sales derived from statistics published in the *1987 Census of Agriculture* (U.S. Department of Commerce 1989). Payroll-to-receipts ratios ranged from 11 percent for farms primarily growing cash grains to 32 percent for farms primarily growing vegetables, fruits, and tree nuts. This analysis used the ratio for general crop farms, which was 21 percent. Employee benefits in agriculture are lower than in other industries, so wages represent nearly all of labor costs. Wages were estimated as 80 percent of labor costs. The number of year-round equivalent direct jobs displaced was estimated from the wage loss using average weekly earnings for crop production workers in the San Joaquin Valley (Employment Development Department no date).

Impacts on farm income were estimated by multiplying impacts on total crop production by the ratio of farm income and agricultural production for the San Joaquin Valley in the years 1986–1992. Farm income consists of agricultural wages and salaries plus income of farm proprietors. The ratio was estimated from crop production as reported by the California Department of Food and Agriculture and farm income as estimated by the U.S. Bureau of Economic Analysis.

The regional effects of reduced farm production were estimated using input-output analysis. Multipliers were estimated using the Implan system (1991 database), developed by the Minnesota Implan Group, Stillwater, Minnesota.

The job multiplier gives an estimate of the total number of jobs supported by each job in crop production. The multiplier includes the job in crop production. Thus, the multiplier for the San Joaquin Valley indicates that each job in crop production supports 1.4 jobs with suppliers and in businesses serving employees of farms and businesses supplying farms. The indirect job displacements shown in Table XI-8 were estimated using this figure.

The income multiplier gives an estimate of the total amount of income in the region created by each dollar in income in agriculture. Again, since the multiplier includes the income in agriculture, the multiplier for the San Joaquin Valley indicates that every million dollars in wages and salaries and proprietors' income in agriculture supports 1.7 million in personal income in the rest of the economy.

D. SUMMARY

The proposed flow alternatives will affect water deliveries to farms in the Central Valley and to water utilities in the San Francisco Bay Area and southern California. As a result, crop production will be reduced and water utilities will have to seek other sources of water or take measures to reduce water use by their customers. Depending on the alternative, water deliveries to agriculture are reduced by an average of 158 to 668 TAF per year compared to deliveries under D-1485. Average deliveries to urban water users are reduced by 51 to 75 TAF per year.

As a result of these reductions in deliveries, average net income in agriculture is reduced by an amount ranging from $14 million to $53 million annually. Economic impacts are higher in dry years because, under most alternatives, water supply impacts are higher and because water tends to be used on more valuable crops. In dry years, defined as the ten percent of years with lowest water deliveries, the proposed alternatives reduce net income in agriculture by $50 to $75 million compared to D-1485.

Reduced agricultural production will result in job losses in agriculture and businesses serving farmers and farm workers. Depending on the alternative, average job losses in agriculture range from about 400 to 1,100. Job losses in other industries range from 500 to 1,600. In dry years, job losses are higher, raging from 1,300 to 1,900 in agriculture and from 1,800 to 2,700 in other industries.

Although these job losses may cause individual hardship and may affect some communities adversely, they are too small to have any significant regional impacts and are likely to be absorbed as other sectors of the economy grow. For example, in Kern County, Alternatives 2 and 8 have the most severe impacts. However, even in dry years, these impacts do not exceed one percent of total employment in the county. Alternative 5 results in a loss of 670 jobs in dry years in the area diverting water from the Feather River and its tributaries, but this is less than half of one percent of total employment in Nevada, Placer, Sutter, and Yuba counties.

Impacts on urban water users depend largely on the ability of utilities to secure supplies of transferred water. If all of the water supplies are replaced by transferred water, the total cost to utilities will average $12 million to $17 million annually. Payments to farmers for transferred water will offset the income losses from reductions in water deliveries to agriculture. However, if water

utilities respond to the standards by imposing rationing on their customers, the resulting shortage costs are estimated to range from $70 to $110 million annually.

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