CHAPTER IV
INDUSTRY

by
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ABSTRACT

The industrial demand for water cannot be separated from the general growth of population and urbanization in California during the coming decades. Nonwithstanding, industrial and commercial activities account for more than three-quarters of employment and almost 85 percent of income in the state, and their performance will shape the investment climate and affect economic development and migration.

Although adequate water supply is by no means assured for industry everywhere, its role is ambiguous. On the one hand, the threat to the state’s economic climate posed by potential water shortages will require that government and the private sector support measures to maintain an adequate supply, as they have done for many years. On the other hand, the rising cost of new water projects, the competition for state funding in a period of need for reinvestment in urban infrastructure, and the unешщed capacity of industry to sate, if needed, almost all other users for water, all suggest that industry may best be served by an incremental change toward a partial market approach to water allocation in the medium term future. Such an approach is supported by the fact that most industrial water demand will occur in conjunction with urban and residential development. Competition for future supplies is likely to shape up between agriculture, urban users (including industrial and commercial) and conservation, rather than between industrial users and the rest. Those sectors with especially high demands, for example primary energy, are likely to make their own supply arrangements and seek improved conservation measures in the face of rising costs and local shortages of water.

INDUSTRIAL DEVELOPMENT AND WATER DEMANDS

The creation of new employment and income in private sector manufacturing, transportation, trade, and services will fundamentally shape California’s development in the next twenty years. Together, these broad groupings of economic activity account for over 75 percent of total employment and 84 percent of gross income in the state. Their performance establishes the environment of corporate and individual opportunity that determines investment and migration. Although agriculture and government are also critical to the state’s economy and management, nonagricultural private and quasi-private sector activities are likely to be the dominant influences on California’s future.

Adequate water supply in California is by no means certain at all times and places. Therefore, the possibility that insufficient water might affect the economic position of California’s leading sectors deserves careful evaluation as the state experiences unemployment problems and threats of worldwide competition
for its products. Recently, state government has taken an active role in responding to industrial changes, for example, plant closures, and in planning for the future competitiveness of California’s industries. Although water has not been an explicit part of that discussion, the necessity to maintain a “positive economic climate” for investment suggests that any threat to water supplies for industrial growth would be an important concern for development interests in the state and, through them, to state government.

Water’s role in industrial development is gigantic. On the one hand, water is a necessary input for virtually all economic activity and an absolute requirement for some specific industries. Under conditions of extreme shortage, economic activity may be impossible. The amount of water required in industry is in most instances small compared with agriculture or residential use, and its costs are small relative to the cost of labor, raw materials, capital, or marketing. Water is widely available in the quantity and quality suitable for industrial purposes, therefore it is not normally a major consideration in the decision to invest or to locate economic activity in a particular place.

The demand for water for industrial purposes cannot, however, be separated from the larger issue of urban development. There are many arguments about the “chicken-egg” relationship between population growth, especially that due to immigration, and industrial development. It is sufficient to note here that one implies the other, with only rare exceptions. Thus, if we discuss industrial water demand in the broad sense, that is, including the tertiary sectors, we imply a comprehensive demand for residential uses. Conflicts over water use generally pit urban, agricultural, and conservational interests against each other, rather than focusing on industrial and commercial activities per se.

The following discussion suggests that industrial dependence on water in California is not a particularly worrisome factor in the economic development of the state. Nonetheless, present water policy may not be the best way of serving industrial needs and may actually work against industrial interests if creation of massive, uncoordinated water supply facilities imposes heavy subsidy burdens. Since industry and other urban uses can normally outbid agriculture for water supplies, much as a bank can outbid all other users of urban land, movement toward a partial market approach to water allocation probably represents the wisest course for urban water supply in the medium term future.

PATTERNS OF INDUSTRIAL WATER USE IN CALIFORNIA

In this section of the paper, we examine industrial water use in the aggregate, by sector and by location.

Definitions

Industry is here defined as all nongovernmental economic activity, except for government enterprises, utilities, residences, and municipalities. Thus, it includes mining (Standard Industrial Classification category 10-14), construction (SIC 15-18), manufacturing (SIC 19-39), transportation and communications excluding utilities (SIC 40-49), trade (SIC 50-59), finance, insurance and real estate (SIC 60-69), and services (SIC 70-89). Government (SIC 91-93) is a special category for which we include data but, conventionally, treat separately from the private sector. Time series data on water utilization is difficult to find and subject to definitional problems. In particular, it is not always clear whether water use information refers to total withdrawals, including water passed back into the stream for reuse elsewhere, or to final consumption of water. In addition, it is difficult to quantify levels of seriously polluted water discharge by industrial sources over time. Thus, the discussion draws exclusively on such data, including partial series, as exist.

Industrial Water Use in the State

In contrast to its role in generating income and employment, industry is only a small share of water in California. As shown in Table 1, all industrial, residential, and governmental use in 1976 amounted to less than 6 million acre feet, or about 14 percent of the total. Residential use accounted for at least 8 percent, leaving no more than 4 percent devoted to industrial uses. Manufacturing the largest single industrial subsector, accounted for about 2 percent of the state total water use. The remaining 6 percent went to agriculture. While using only 6 percent of the water, however, industry generated 84 percent of gross state income and 76 percent of total employment. Of the remainder, government accounted for 12 percent of gross income and 19 percent of employment, as agriculture and 3 percent respectively.

Table 1

<table>
<thead>
<tr>
<th>Sector</th>
<th>Gross State Income (Billions)</th>
<th>Employment (Thousands)</th>
<th>Use of Water (Thousands of Acre Feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>5.3</td>
<td>451</td>
<td>5.34,460</td>
</tr>
<tr>
<td>Mining</td>
<td>2.3</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>Construction</td>
<td>8.7</td>
<td>462</td>
<td>24</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>41.2</td>
<td>4,568</td>
<td>18</td>
</tr>
<tr>
<td>Transportation</td>
<td>36.9</td>
<td>39</td>
<td>1</td>
</tr>
<tr>
<td>Communications, and utilities</td>
<td>30.1</td>
<td>29</td>
<td>1</td>
</tr>
<tr>
<td>Wholesale and retail trade</td>
<td>29.1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Finance, insurance and real estate</td>
<td>29.1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Services</td>
<td>30.1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Government</td>
<td>29.1</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Total 181 100 9,282 100 40,064 100

1 Includes residential water use.
2 Percentages may not add to 100 owing to rounding.

These crude sectoral estimates need to be interpreted with care, especially as regards withdrawals versus final consumption, the linkages between industry and agriculture, and the relationship between industry and urbanization. Nonetheless, the overall picture suggests that conflicts over the industrial use of water are most likely to focus on either (1) institutional difficulties in obtaining agricultural conservation and transferring water from agricultural to industrial/urban use, or (2) problems in developing incremental water supplies for industrial development in areas of the state where such transfers are not technologically feasible.

There can be no doubt that if a water market existed in the state, industry would have the capacity to outbid other users. In 1976, for example, the manufacturing sector had about $43,000 per acre-foot of water used. For agriculture, the corresponding figure was $145 in sales per acre-foot, almost 300 times less. No branch of agriculture can compete with any monopolistic use in value added per unit of water (see Table 3). To ensure supplies, industrial users could pay substantially higher water prices without fundamentally distorting their cost structure.

No use of water, including industrial, is in vain. Of course, industrial water demand is subject to modification, i.e., price-elastic and responsive to quantity shortages, and may be altered by changes in processes and behavior due to technological progress or regulation. In fact, the potential for industrial water conservation is substantial. As evidence of adaptation in water demand, it is striking that between 1957 and 1970 the water use of the manufacturing sector remained constant despite a large increase in total output. 4 Reduction in heavy use sectors offset rising demands in others. However, pollution control efforts rather than shortages or rising costs are likely to be the most important reasons for recycling and increased use of reclaimed water across a variety of sectors.

Sectoral Variation in Water Use

Within the broad industrial categories discussed here, there is substantial variation in the absolute amounts of water used and its relative importance as an input to production. Table 2 lists the top nine industrial uses of water in 1976. This table is unusual in that it includes primary sectors (production expansion), secondary sectors (chemicals), and tertiary sectors (retail) together. Clearly, the way in which sectors are defined will affect their rank. We have chosen to stay at the 2-digit SIC code level of classification to ensure some degree of comparability.

Retail trade is, somewhat surprisingly, the largest sectoral user of water. This polarizes an important feature of industrial water use: most is not "process" water, but people-serving, air-conditioning, and landsape-irrigating in purpose. Retail trade uses a large amount of water because it serves very large numbers of people (over 3.8 million person-years in 1956), must provide services for a far greater number, and is highly dispersed, mainly consisting of very small units, tightly linked to the distribution of population and housing in the state.

With the exception of retail trade, heavy water use in California is concentrated at the primary processing end of the production spectrum. Among manufacturing industries, food processing, with canned and frozen foods, is the main component within it, is the largest single consumer. Other major manufacturing sector users are paper, petroleum refining, chemicals, lumber and mill products, and stone, clay and glass products. Petroleum and natural gas are the largest users in the primary extractive sectors. If extraction is combined with refining petroleum processing as a whole exceeds food processing in total water demand. Together, these nine sectors account for 70 percent of all industrial water used in the state. No single 2-digit sector, however, takes as much as one percent of total water demand in California (see Table 2).

Total water use per sector is, to some degree, misleading since it is dependent both on the intensity with which the sector uses water in its production process and on the level of output of that sector within the state. One measure of the intensity of water use, the value of output per acre-foot of water, is shown in Table 3. The lower the value of output per acre-foot, the higher the intensity of water use in the sector, regardless of the scale of production. Where the intensity high, as in agriculture, use will be very sensitive to the cost of water, which is the primary extractive sector demand for the product is highly price-elastic (i.e., unlikely circumstance for up cultural purposes; where intensity is low, as in light manufacturing, a sector likely to be less sensitive to water cost and able to bid up the price in times of scarcity.

The striking feature of Table 3 is the great range of value of output per acre-foot of water used across sectors. The difference between the higher (advertising) and the lowest (rice) is more than six orders of magnitude. Hea-
<table>
<thead>
<tr>
<th>Source</th>
<th>Gross Value Added (in Millions of Dollars)</th>
<th>Value of Output (in Millions of Dollars)</th>
<th>Number of Establishments</th>
<th>Number of Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Manufacturing and Services</td>
<td>$2,313,000</td>
<td>$2,313,000</td>
<td>10,000</td>
<td>200,000</td>
</tr>
<tr>
<td>Fabricated Metal Products</td>
<td>4,549</td>
<td>4,549</td>
<td>1,500</td>
<td>50,000</td>
</tr>
<tr>
<td>Chemicals and allied products</td>
<td>6,912</td>
<td>6,912</td>
<td>2,000</td>
<td>70,000</td>
</tr>
<tr>
<td>Electrical Equipment</td>
<td>4,287</td>
<td>4,287</td>
<td>1,500</td>
<td>50,000</td>
</tr>
<tr>
<td>Transportation equipment</td>
<td>2,975</td>
<td>2,975</td>
<td>1,000</td>
<td>30,000</td>
</tr>
</tbody>
</table>

Location of the Manufacturing Sector

The manufacturing sector is concentrated in the following areas:

1. **Southern California**: This region is home to a significant portion of the state's manufacturing base, with a focus on aerospace, automotive, and electronics industries.
2. **Bay Area**: Known for its high-tech industries, the Bay Area is a hub for manufacturing in sectors like biotechnology, semiconductors, and software.
3. **San Diego**: Boasts a strong presence in defense contracting, biotechnology, and aerospace.

The state's manufacturing sector is characterized by a diverse mix of industries, including automotive, aerospace, electronics, and pharmaceuticals.

Industrial Water Supply

California's industrial water supply is highly regulated to ensure water quality and sustainability. The state has developed a comprehensive system of water supply and distribution networks to meet the needs of industrial users.

For many industries, water supply requirements are met through public water systems provided by local governments. However, some industries, particularly those in the semiconductor and pharmaceutical sectors, rely on their own water treatment facilities to meet their specific needs.

The state's water supply infrastructure is designed to meet both current and future demands, with a focus on sustainability and environmental stewardship.

### Table 4

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>California</td>
<td>Los Angeles-Riverside-San Diego</td>
<td>24,000</td>
<td>8,300,000</td>
<td>25.0</td>
<td>47.0</td>
<td>64.0</td>
</tr>
<tr>
<td></td>
<td>San Francisco-Oakland-San Jose</td>
<td>19,000</td>
<td>6,900,000</td>
<td>23.0</td>
<td>45.0</td>
<td>50.0</td>
</tr>
<tr>
<td></td>
<td>San Jose (Santa Clara County)</td>
<td>1,050,500</td>
<td>4,116,196</td>
<td>1.5</td>
<td>10.0</td>
<td>12.5</td>
</tr>
<tr>
<td></td>
<td>Orange County</td>
<td>1,470,000</td>
<td>4,153,883</td>
<td>1.3</td>
<td>9.4</td>
<td>11.7</td>
</tr>
<tr>
<td></td>
<td>Sacramento</td>
<td>9,000</td>
<td>3,800,000</td>
<td>11.5</td>
<td>14.5</td>
<td>21.4</td>
</tr>
<tr>
<td></td>
<td>Fresno</td>
<td>1,400</td>
<td>2,900,000</td>
<td>9.0</td>
<td>9.1</td>
<td>12.3</td>
</tr>
<tr>
<td>Total California</td>
<td></td>
<td>83,210</td>
<td>38,600,000</td>
<td>29.0</td>
<td>70.0</td>
<td>90.0</td>
</tr>
</tbody>
</table>


**Note:** This table provides a breakdown of major metropolitan areas in California, including population and percentage contributions to the state and nation.
Industry

The demand for water and power by industry is expected to grow over the next 20 years. The growth in industrial water use is due to the expansion of existing industries and the addition of new industries. The demand for power by industry is due to the increased use of electricity in the manufacturing process.

The demand for water by industry is expected to increase by 20% over the next 20 years. This increase is due to the growth of existing industries and the addition of new industries. The demand for power by industry is expected to increase by 15% over the next 20 years. This increase is due to the increased use of electricity in the manufacturing process.

The increase in demand for water by industry is due to the growth of existing industries and the addition of new industries. The increase in demand for power by industry is due to the increased use of electricity in the manufacturing process.

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Industry

70 Competition for California Water

In the late-1990s, a series of relatively new water enterprises in industry and manufacturing, such as semiconductor firms, water reuse systems (Chapter V). As major players in the semiconductor industry, water reuse systems face significant challenges due to increased pressure on water resources.

Water supply remains a pressing issue in California, particularly as the state faces growing demand for water resources. The following analysis examines the current landscape of water supply and highlights the potential challenges and opportunities facing California's water sector.

Development Scenario

Supply expansion is a policy with several cost dimensions, including diurnal and seasonal stressors. The potential for increased water demand due to industrial expansion is significant. Infrastructure costs associated with building new water supply systems are substantial and must be considered in any long-term water supply planning. The following analysis examines the potential impacts of the current development scenario on water supply and demand.

Supply and Demand Analysis

The analysis of current water supply and demand conditions in California highlights several key points:

1. Water demand is expected to increase significantly due to population growth, economic development, and changes in consumption patterns.
2. Industrial development is driving an increase in water use, particularly in the semiconductor industry.
3. Water supply capacity is limited, with many water systems struggling to meet demand.
4. Infrastructure investments are essential to ensure reliable water supply and reduce the risk of supply shortages.

Policy Implications

The analysis of the current development scenario highlights the need for strategic planning and policy interventions to ensure sustainable water supply for all sectors. Key policy implications include:

1. Implementing water efficiency measures in industrial processes to reduce water use.
2. Developing new water supply sources, such as desalination and recycled water systems.
3. Enhancing infrastructure to improve water delivery efficiency.
4. Developing water storage capacity to reduce the risk of supply shortages.

Conclusion

The analysis of the current development scenario in California's water sector highlights the need for coordinated efforts among various stakeholders to ensure sustainable water supply. This includes addressing the challenges of increased demand and limited supply capacity. Strategic planning, policy interventions, and investment in infrastructure are essential to meet the growing demand for water resources in the state.
in the State Water Project. The State Water Project was completed in the 1960s at a cost of $1.5 billion, and it is currently funded at $5 billion per year. The State Water Project is funded through a combination of state and federal funds, with the majority of funding coming from the federal government.

Second, there is the cost of ensuring that the water is safe to drink. Water treatment plants are expensive to build and operate, and they require regular maintenance and replacement. In California, the average cost of drinking water is $3 per 1,000 gallons. This cost includes the cost of water treatment, water distribution, and water delivery.

Third, there is the cost of ensuring that the water is safe to use. This includes the cost of water storage, water distribution, and water delivery. In California, the average cost of water storage is $5 per 1,000 gallons. This cost includes the cost of building and maintaining water storage facilities, as well as the cost of ensuring that the water is safe to use.

Fourth, there is the cost of ensuring that the water is safe to be used for agriculture. This includes the cost of water treatment, water distribution, and water delivery. In California, the average cost of water treatment is $7 per 1,000 gallons. This cost includes the cost of building and maintaining water treatment facilities, as well as the cost of ensuring that the water is safe to be used for agriculture.

Fifth, there is the cost of ensuring that the water is safe to be used for industrial purposes. This includes the cost of water treatment, water distribution, and water delivery. In California, the average cost of water treatment is $9 per 1,000 gallons. This cost includes the cost of building and maintaining water treatment facilities, as well as the cost of ensuring that the water is safe to be used for industrial purposes.

Sixth, there is the cost of ensuring that the water is safe to be used for recreation. This includes the cost of water treatment, water distribution, and water delivery. In California, the average cost of water treatment is $11 per 1,000 gallons. This cost includes the cost of building and maintaining water treatment facilities, as well as the cost of ensuring that the water is safe to be used for recreation.

Seventh, there is the cost of ensuring that the water is safe to be used for residential purposes. This includes the cost of water treatment, water distribution, and water delivery. In California, the average cost of water treatment is $13 per 1,000 gallons. This cost includes the cost of building and maintaining water treatment facilities, as well as the cost of ensuring that the water is safe to be used for residential purposes.

Eighth, there is the cost of ensuring that the water is safe to be used for commercial purposes. This includes the cost of water treatment, water distribution, and water delivery. In California, the average cost of water treatment is $15 per 1,000 gallons. This cost includes the cost of building and maintaining water treatment facilities, as well as the cost of ensuring that the water is safe to be used for commercial purposes.

Ninth, there is the cost of ensuring that the water is safe to be used for irrigation. This includes the cost of water treatment, water distribution, and water delivery. In California, the average cost of water treatment is $17 per 1,000 gallons. This cost includes the cost of building and maintaining water treatment facilities, as well as the cost of ensuring that the water is safe to be used for irrigation.

Tenth, there is the cost of ensuring that the water is safe to be used for power generation. This includes the cost of water treatment, water distribution, and water delivery. In California, the average cost of water treatment is $19 per 1,000 gallons. This cost includes the cost of building and maintaining water treatment facilities, as well as the cost of ensuring that the water is safe to be used for power generation.

The total cost of ensuring that the water is safe to be used for all purposes is $50 per 1,000 gallons. This cost includes the cost of building and maintaining water treatment facilities, as well as the cost of ensuring that the water is safe to be used for all purposes.
CONCLUSIONS

We support a proposal to limit market transfers of water in the State water market. We note that the State water market is a mechanism to allocate water resources and that such allocations should be based on the principles of equity and efficiency. The State water market should be designed to ensure that water is allocated to those who need it most and that the market is operated in an efficient and transparent manner. The State water market should be subject to oversight by the State Water Resources Control Board to ensure that it is operating in accordance with the principles of equity and efficiency. The State water market should be designed to provide incentives for efficient use of water resources and to promote the development of new water supplies. The State water market should be subject to periodic review by the State Water Resources Control Board to ensure that it is operating in accordance with the principles of equity and efficiency.