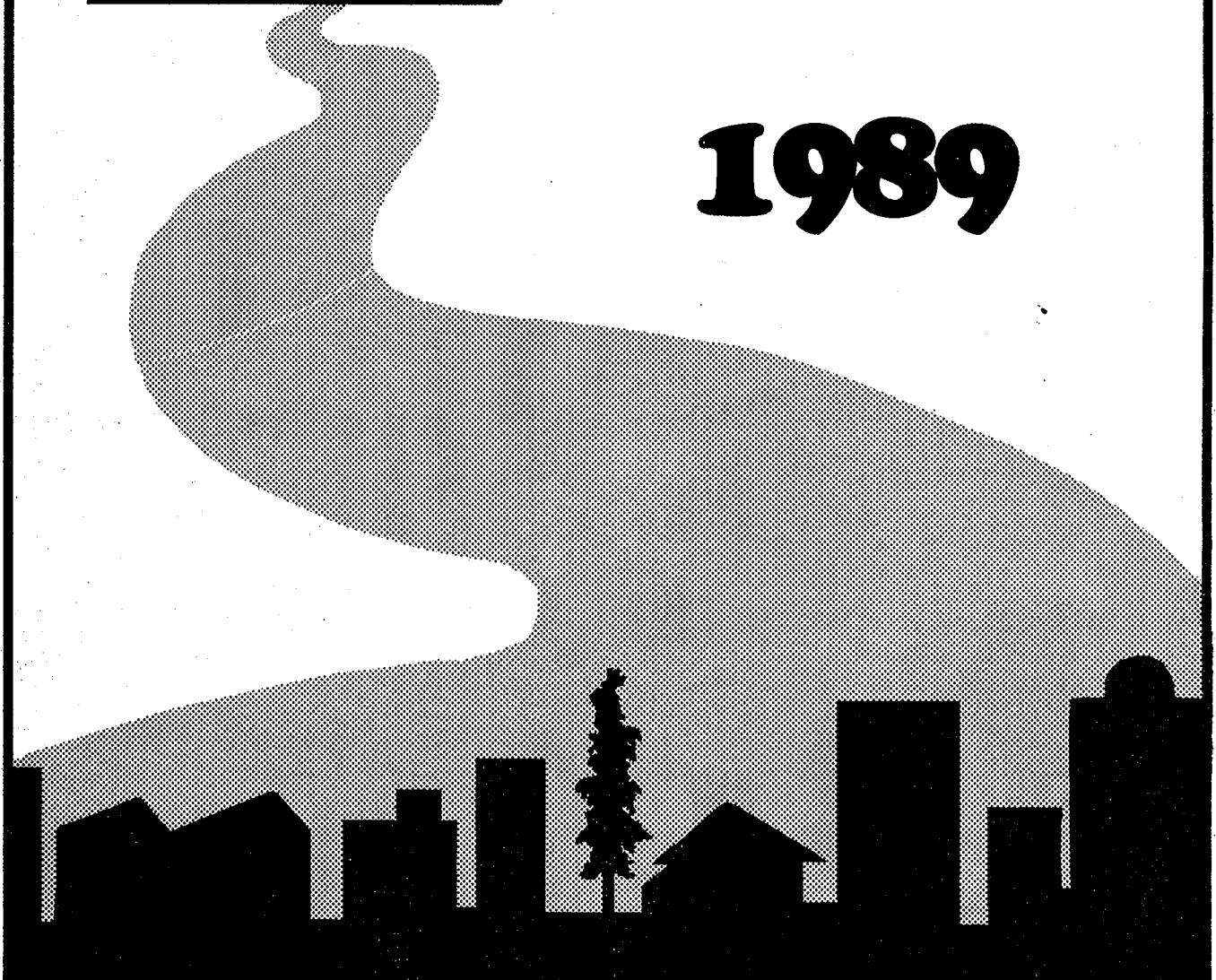


Water Utility Plan



1989



**CITY OF PALO ALTO UTILITIES DEPARTMENT
250 Hamilton Avenue, Palo Alto, CA 94303**

CITY OF PALO ALTO
UTILITIES DEPARTMENT
RESOURCE PLANNING DIVISION

1989
WATER UTILITY
PLAN

SEPTEMBER 1989

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1. EXECUTIVE SUMMARY

1.1 Purpose

The 1989 Water Utility Plan (Plan) is designed to serve as the planning guide to be used in meeting future Water Utility requirements. The Plan outlines historical, existing and anticipated future conditions as they relate to demand, supply and operations, and recommends courses of action for responding to those conditions. It is important to note that the Plan is a snapshot of a dynamic situation. It is intended to be proactive yet flexible, in view of future uncertainties.

Development of the Plan is consistent with Goal VI, Objective 8, Strategy E of the City of Palo Alto Utilities Department Strategic Plan.

1.2 Background

The City of Palo Alto Water Utility was formed in 1896 when the City began operation of the municipal well system. Well water was the City's sole source through the year 1938 when the supply was supplemented with purchases from the San Francisco Water Department's (SFWD) Hetch-Hetchy water system. In 1962, continuous operation of the wells was terminated and the SFWD became the City's sole supplier.

For the intervening 15-20 years the Water Utility has been operating, for the most part, as a distribution service wherein maintenance and infrastructural activities dominated. The City wells were maintained as an emergency source of supply and water quality monitoring and facilities maintenance kept pace with evolving situations and regulations. The drought of 1976-77 and the recent 1987-89 drought focused attention on water as a limited resource, stimulating a higher level of water awareness among the City's private and corporate citizens. But recently, the heretofore stable environment of the local water industry has begun to change.

The high rate of growth in population and commercial/industrial activity in California is pushing the limits of the west's limited water resources. State action may alter century-old water rights and modify the state's existing water allocations. Furthermore, increasingly stringent drinking water standards may require extensive capital investments. All this comes at a time when the infrastructure of Palo Alto is reaching the end of its useful life and will require extensive and costly rehabilitation.

Long-term water utility planning is critical in the face of this changing environment. This Plan attempts to capture the essence of that environment, and makes recommendations for guiding the City's Water Utility through the uncertain future.

A first step in planning for the future is forecasting the City's long-term water needs. A twenty-year water consumption forecast completed in February 1989 projects virtually no

growth over 1984 levels. Variables affecting the forecast include rainfall, temperature and population. While the areas surrounding Palo Alto have experienced significant growth, the City has maintained and is expected to continue to maintain a relatively stable population. The forecast represents a slight decrease in per-capita consumption, reflecting the City's commitment toward continued emphasis on increasing efficiency of use.

The nature of the City's contract with the SFWD means that if, in fact, demand stays close to current levels, the City will be guaranteed a large portion of that demand. Nonetheless, the anticipated "gap" between supply and demand, as well as the circumstances involving the SFWD system necessitate that the City be proactive on supply issues.

In the near term (in the mid-1990's), the SFWD system may face a peaking capacity shortage due to the size of its cross-valley transmission facilities. During high demand periods, which coincide with hot summer weather patterns, the transmission system may reach its hydraulic capacity limit. Solutions currently being considered include construction of an additional cross-valley pipeline and/or increased off-stream storage. However, political and environmental resistance to both options is anticipated; therefore, Palo Alto needs to examine the feasibility of meeting its daily and seasonal peaking requirements independently or jointly with other local water utilities.

In the long term, the SFWD system will be unable to meet currently projected levels of demand. Strategies for meeting long-term system needs include: 1) increase storage capacity to capture additional runoff; 2) seek alternative sources of supply; 3) reduce consumption through demand-side measures.

Increasing system storage, either by raising the O'Shaughnessy dam or by building new dams, is difficult in light of political and environmental constraints. Additionally, the State Water Resources Control Board's, Bay-Delta Hearings which are currently in progress, could alter (i.e., limit) the SFWD's water rights such that further entitlements would be prohibited.

As such, the City should pursue supply alternatives to Hetch-Hetchy. Alternatives presently under consideration include the Santa Clara Valley Water District (SCVWD), the City well system and water reclamation. The utilization of any of these sources would involve initial capital outlays for transmission facilities and possible compromises in water quality. Consideration of these sources lends itself well to the concept of the segmentation of the water market into high and low quality uses.

Another option that can be used in conjunction with the above-mentioned supply-side measures is the adoption of demand-side programs. Demand-Side Management (DSM), like other sources of supply, can reduce the difference between supply and demand but has the advantage of fewer political and environmental impacts.

Irrespective of any particular source of supply, the "hidden" but critical link from source to use is the City's infrastructure. The system of pipes, valves, connections, receiving and

booster stations, reservoirs and wells deserves ongoing attention. The City's maintenance program is currently having to operate in a reactionary mode and is reacting to an alarmingly accelerating rate of main breaks. Assuring the distribution system reliability and adequate customer services in the future will be increasingly difficult given the condition of the system and existing staffing levels. Also, increasingly stringent water quality requirements are anticipated; therefore, the City should prepare for substantial increases in testing and reporting requirements, along with the associated expenses.

1.3 Recommendations

The Water Utility is facing many challenges in its uncertain future. The following recommendations are intended to serve as a guide to Utility planning in the face of such uncertainty.

1. Maintain leadership role in the Bay Area Water Users Association.
2. Refurbish the wells that are recommended to remain in the water system and maintain them in a condition and manner consistent with their intended use.
3. Continue working with the SFWD and the Bay Area Water Users Association Planning Committee to address contractual issues and to study the feasibility of facilities that may alleviate the peaking problem.
4. Evaluate the operational feasibility of using existing City storage and distribution facilities for water supply during peak periods.
5. Closely monitor the proposed modification to the Safe Drinking Water Act.
6. Monitor and participate in the Bay-Delta hearing process.
7. Perform a study of Palo Alto's anticipated supplemental needs in order to prepare for the situation when the SFWD system reaches full capacity.
8. Analyze the feasibility of developing new wells.
9. Continue working with the SCVWD staff and examine the feasibility of interconnecting with the SCVWD for future treated water deliveries.
10. Analyze the feasibility of using reclaimed water as a source of supply for certain applications.
11. Support and participate in the proposed United States Geological Survey groundwater study.

12. Continue to pursue demand-side programs for the purpose of promoting efficient use of the City's water resources.
13. Continue to examine rate design in terms of effectiveness in meeting the principal criteria employed by the City, and perform timely comprehensive cost of service studies.
14. Proceed with the current plans on the reservoir improvement project to provide improved seismic integrity and corrosion protection.
15. Proceed with the study regarding recommendations for updating the receiving stations and related monitoring systems.
16. Continue the development and implementation of a comprehensive large meter maintenance program.
17. Reevaluate staffing levels to insure adequate ongoing preventative maintenance involving valve replacement, meter calibration and replacement, fire hydrant upgrades and flow testing.
18. Proceed with the in-house study regarding the appropriate main replacement cycle.
19. Update the Water Utility Emergency Operations Plan to meet current industry standards.

2. FORECAST

A long-term forecast of total City water consumption is produced annually. The most recent forecast, which was done in February 1989, predicts virtually no growth through the twenty-year forecast period (Figure 1). The forecast presented here is the most likely case. Actual use will vary with deviations from expected values in temperature, rainfall, and population growth, the latter of which is significantly influenced by Council policy.

The current forecast predicts a significantly lower rate of growth in water purchases than has been experienced in the past. Reasons for this "leveling out" include the slowing of population growth and building activity, and the conservation ethic resulting from the two recent drought periods (1977-78 and 1987-89).

The most notable aspect of the forecast is that the base case predicts total City consumption will remain below pre-1977 drought levels through the next twenty years.

2.1 Historical Water Use

The two drought periods have had a profound effect on the mindset as well as the mechanisms used in water consumption. Substantial capital investments were made in 1977 toward more water-efficient equipment in the commercial and industrial sectors. New construction in every sector is subject to increasingly stringent regulations regarding water-consuming appliances and fixtures. Additionally, the recent drought has given a boost to the development of extensive demand-side planning activities in the water utility industry.

Figure 2 shows that the percentage of consumption of each customer class has remained virtually constant for the last twenty years and based on the City-wide Land Use and Transportation Study, no major shifts in this trend are expected.

Examination of FY 1987-88 consumption (Figure 3) reveals that the residential sector (single and multiple-family dwellings) is responsible for 50 percent of total city sales, the commercial and industrial sectors consume 40 percent, and public and City facilities use the remaining 10 percent. Further breakdown of a single family residential home (Figure 4) shows that irrigation, showers and toilets represent over 80 percent of the typical home requirements.

CITY OF PALO ALTO WATER CONSUMPTION

Historical and Projected

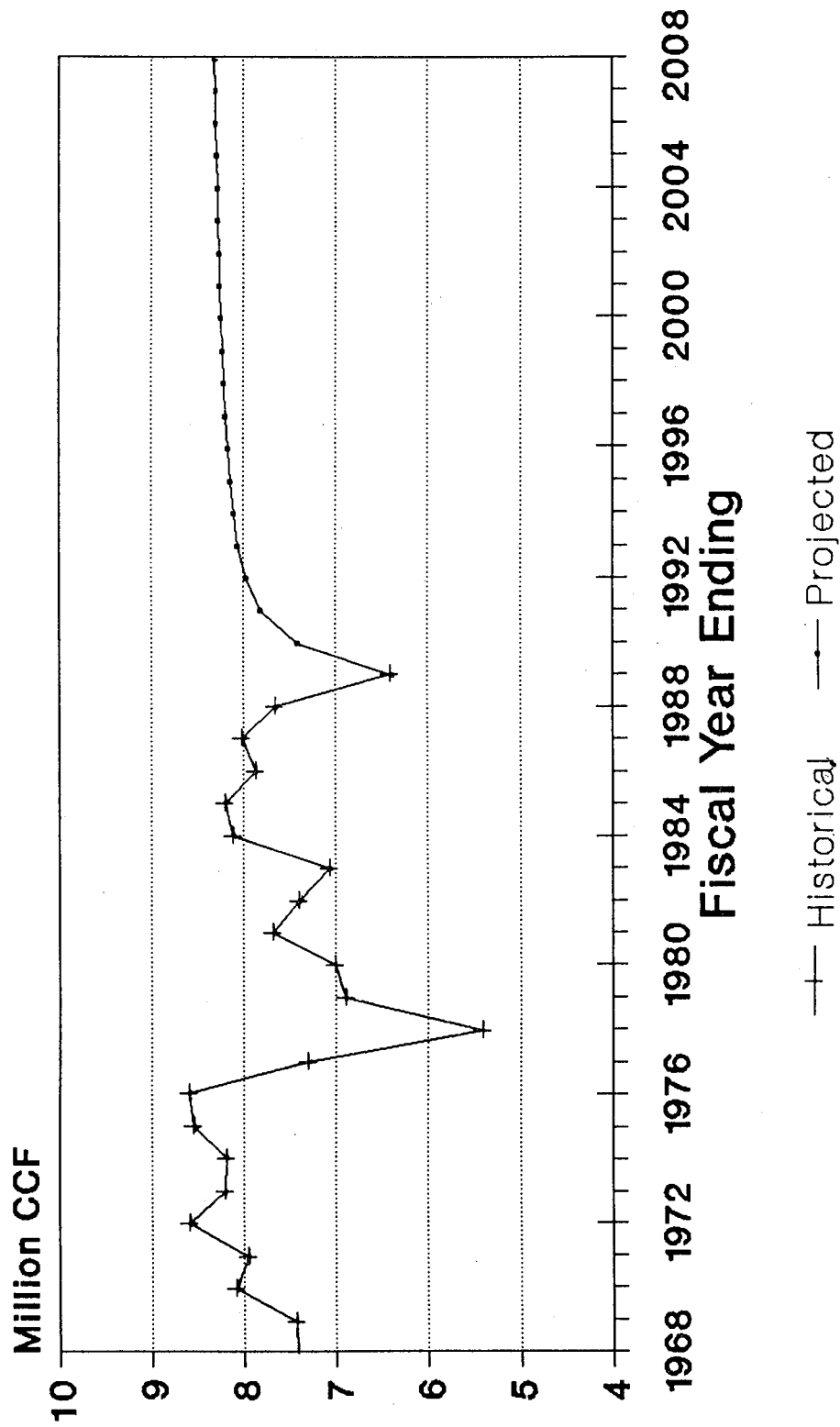


Figure 1

CITY OF PALO ALTO WATER UTILITY CONSUMPTION BY CUSTOMER CLASS

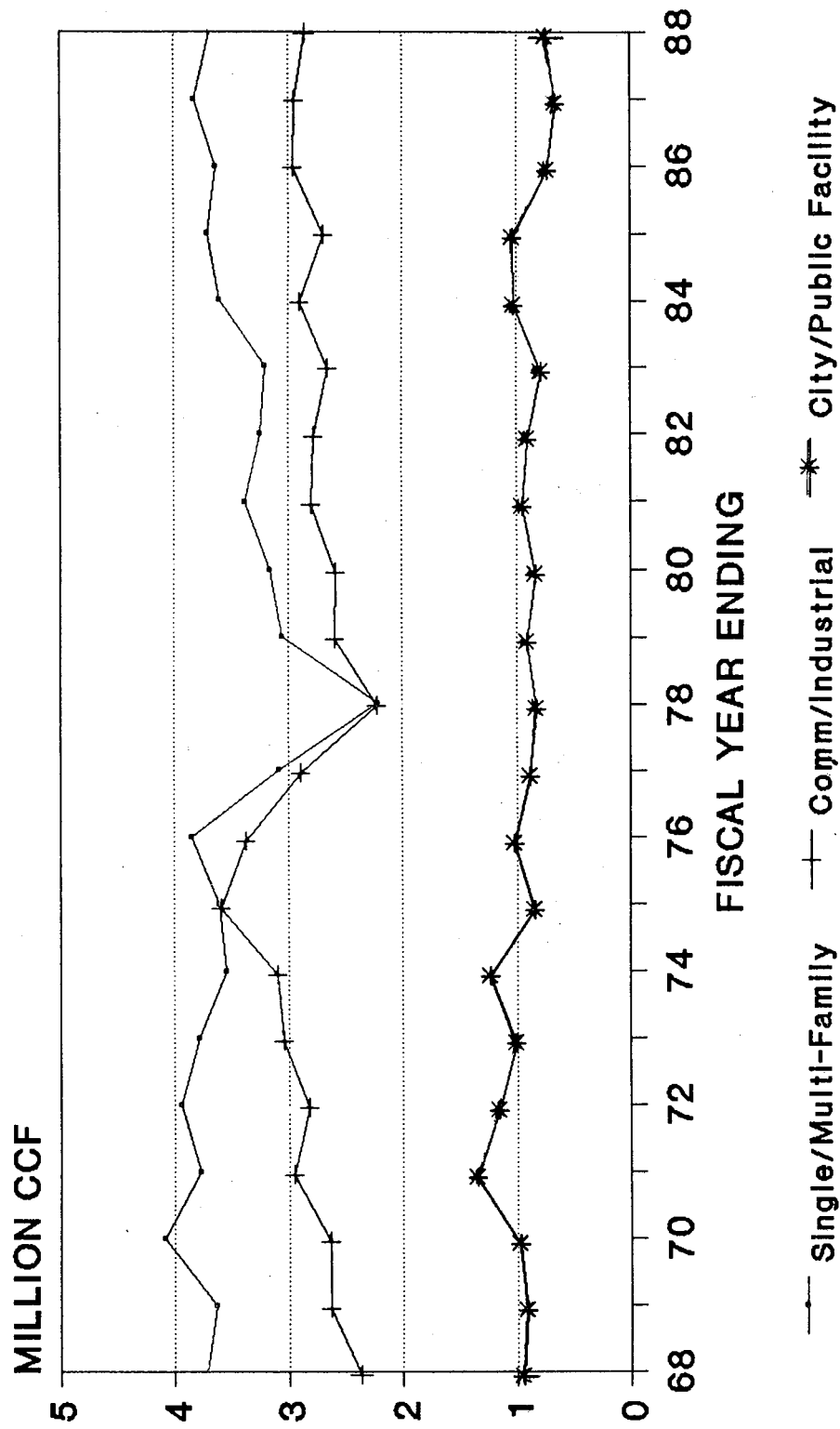


FIGURE 2

CITY OF PALO ALTO WATER UTILITY

FY 1988 Sales By Customer Class

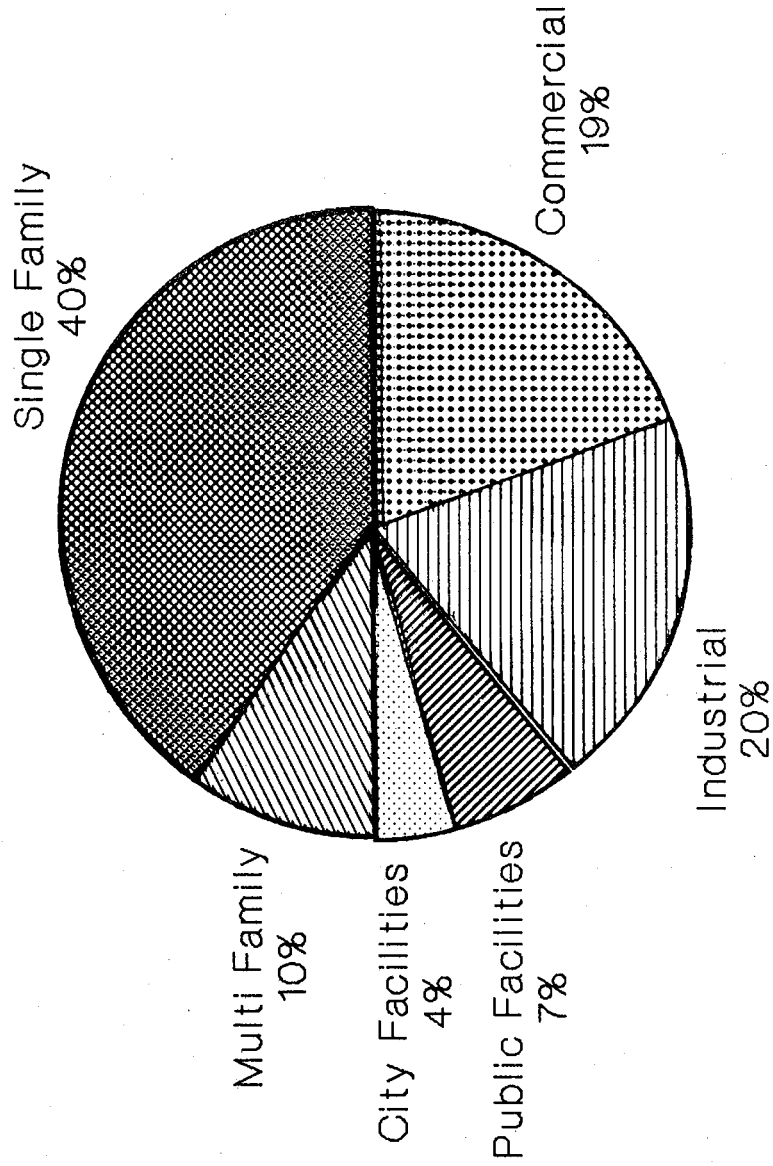


FIGURE 3

TYPICAL RESIDENTIAL WATER USE

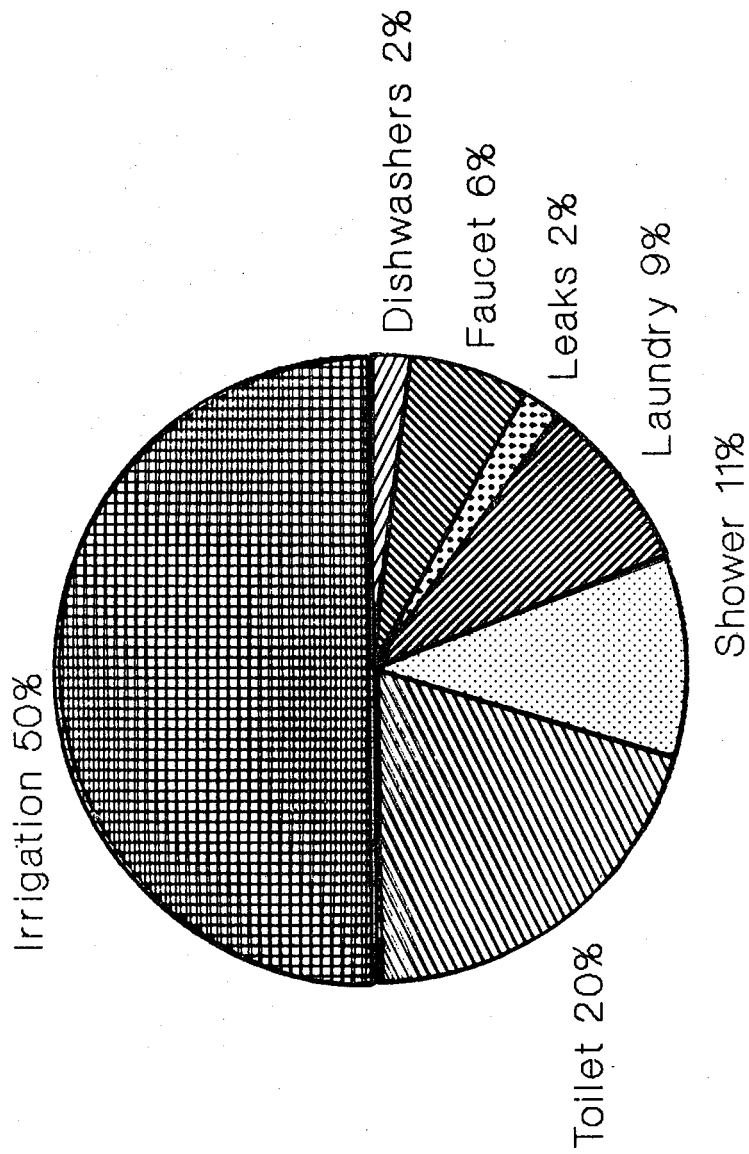


FIGURE 4

2.2 Forecast Methodology

A regression analysis was performed which relates the historical purchases to City population, local rainfall, and local temperatures. In conjunction with the use of variables accounting for seasonal and drought conditions, these factors combine to closely approximate historical purchases.

The base projections reflect the following conditions: drought restrictions ending in May 1989; normal temperature and rainfall as defined by the state Climatologist; and population growth as published by the Association of Bay Area Governments.

Staff has confidence in the current forecast, but is pursuing increasingly sophisticated data collection and forecasting techniques. Emphasis will be towards the development of a thorough data base for each customer class, and the utilization of disaggregate forecasting.

3. RESOURCES

A forecast of future demand defines for a utility the amount of supply it must plan to acquire. Table 1 outlines, and subsequent sections discuss, the strategies available for balancing supply and demand.

3.1 Supply-Side Resources

3.1.1 Existing Resources

3.1.1.1 San Francisco Water Department

A. Contract:

Since 1962, Palo Alto has purchased essentially all of its water from the San Francisco Water Department (SFWD). (Two short-term exceptions will be discussed later.) In 1974, Palo Alto filed a lawsuit against its water supplier, the City and County of San Francisco, in protest of an increase in water rates that was higher for suburban wholesale customers than it was for direct retail customers. Palo Alto is one of thirty water agencies, or Suburban Purchasers, that purchase water wholesale from the SFWD. Several other Suburban Purchasers later joined Palo Alto in the suit.

In 1984, settlement negotiations resulted in the "Settlement Agreement and Master Water Sales Contract Between the City and County of San Francisco and Certain Suburban Purchasers in San Mateo, Santa Clara and Alameda Counties" (Agreement). The Agreement was approved in 1984 and will remain in effect for 25 years.

B. Supply Assurance:

When the Agreement was signed in 1984, each agency's minimum water allocation, or supply assurance, was set. The Agreement stipulates that every three years this supply assurance is to be adjusted to reflect the average amount of water used by each agency during the preceding three-year period. Adjustments are made for increases only; an agency whose average purchases have decreased from the preceding period will continue to receive its prior allocation. The first three-year period was recently completed, and the new allocations are based on usage during fiscal years 1984/85, 1985/86 and 1986/87. Palo Alto's guaranteed annual water purchase amount has been increased from 7,580,463 hundred cubic feet (Ccf) or 15.54 million gallons per day (MGD) to 8,020,744 Ccf or 16.44 MGD (Figure 5). It should be noted that the period covered by the three-year provision can be changed by unanimous consent of the purchasers if any of the years are abnormal. For example, the fiscal year 1988/89 will not be considered in the next calculation due to the drought.

TABLE 1

STRATEGIES FOR BALANCING SUPPLY AND DEMAND FOR WATER SUPPLY

■ **DO NOTHING**

- Accept shortage
- Unplanned rationing

■ **MODIFY SUPPLY**

- Increase supply
 - Provide increased storage or transmission
 - Use groundwater
 - Purchase from alternative suppliers
- Increase efficiency
 - Eliminate leaks
 - Accelerate main replacement
 - Enhance maintenance programs
- Reclaimed wastewater
 - Non-potable uses
 - Potable uses

■ **MODIFY DEMAND**

- Restrictions on use
- Price elasticity
 - Time-of-use/peak pricing
 - Marginal-cost pricing
- Regulation
- Education
- Direct action
- Technical innovations

PROJECTED SOURCES AND USES

Supply Assurance vs. Projected Demand

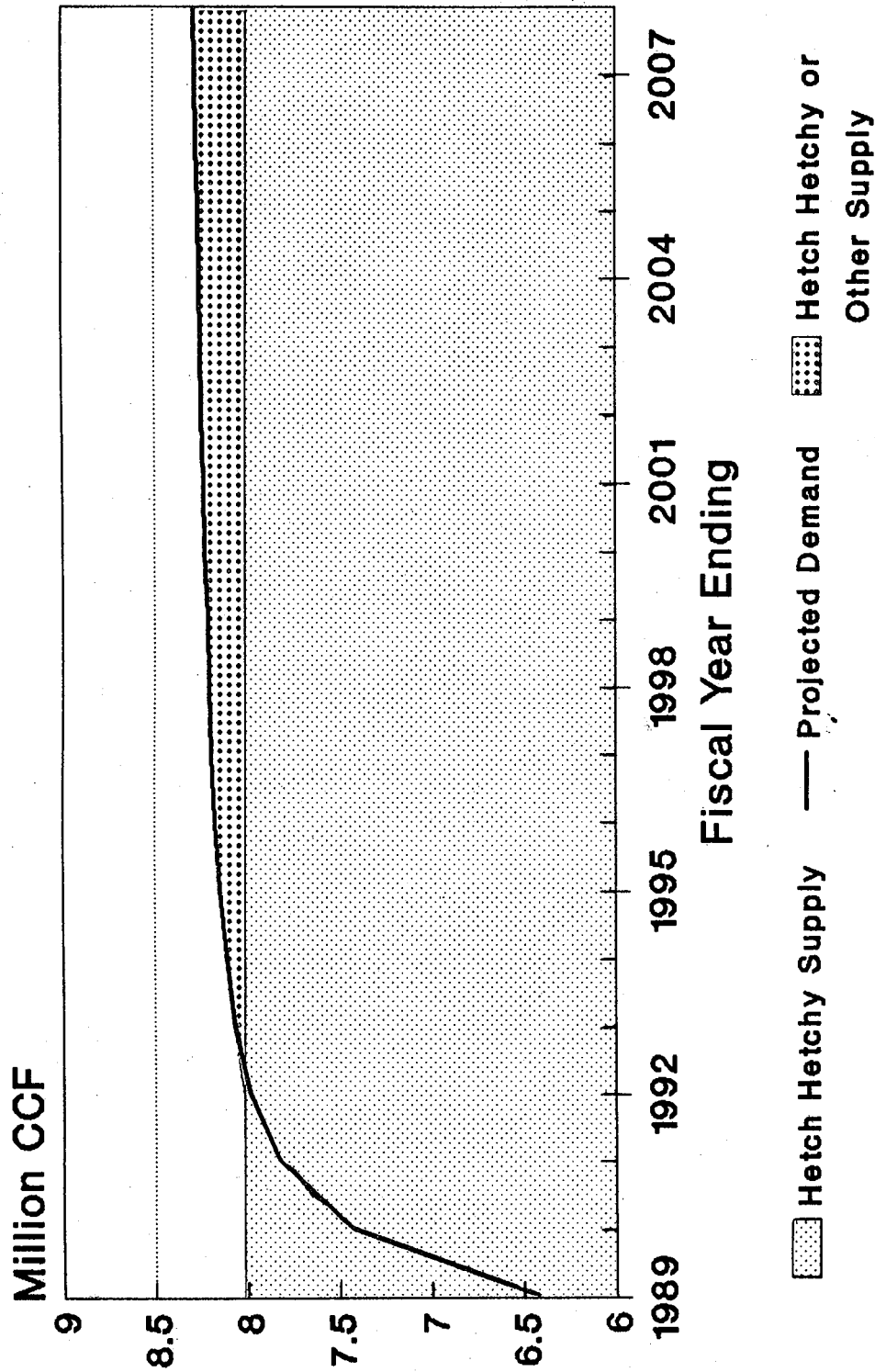


FIGURE 5

The increases in supply assurance will continue until the 30 suburban agencies reach a combined allocation of 184 MGD. As of July 1, 1987, the latest figure unaffected by drought-related conservation, agencies were purchasing 170 MGD. The total allocation (184 MGD) is expected to be reached in the early to mid-1990's. Once the water agencies reach the 184 MGD level, all water above each individual agency's allocation will be charged at a higher unit rate. This higher rate will reflect the SFWD's loss in power revenues which may directly or indirectly result from the sale of water above the 184 MGD level to the suburban agencies and a subsequent decrease in hydroelectric generation.

Although the Master Agreement states that the SFWD guarantees water deliveries only up to 184 MGD for the 30 suburban agencies, the system is capable of delivering additional water. Based on the Bay Area Water Users Association Planning Committee's involvement in the SFWD Master Resource Plan, it is known that the system can currently deliver a total of 325 MGD to both suburban and direct San Francisco customers. While the Agreement recognizes the SFWD's long-term commitment to supply potable water to the suburban agencies, it does not address the relationship between the existing system capabilities and the contractual limitations. Staff will continue its involvement with the Planning Committee in an effort to better define this unresolved contractual issue.

C. Administration:

The agreement recognizes two advisory groups. The first group is the Suburban Advisory Group (SAG) that is made up of one representative of each suburban purchaser. The agreement states that SFWD and SAG shall meet on an annual basis to discuss various topics in order to keep the suburban purchasers apprised of SFWD plans and programs. The second group is the five suburban representatives (SR's) that are selected by the SAG to represent the suburban agencies in the month-to-month administration of the agreement with SFWD. Palo Alto has been appointed as one of the five SR's. A group which is not formally recognized by the contract but which directs the agencies' collective planning efforts is the Bay Area Water Users Association (Association). The group is an unincorporated association of the thirty water agencies served by SFWD.

By providing staff and time to lead the Association and SR's, Palo Alto remains involved in and has opportunities to influence issues that will directly impact the City's ability to provide potable water into the future.

3.1.1.2 Wells

The City of Palo Alto obtained its well system in 1896. The entire water supply for the City was derived from wells until 1938 when the purchase of the San Francisco Water Department's Hetch-Hetchy water was initiated. In 1962, the continuous operation of the well system was terminated and San Francisco water became the City's main source of supply.

Nonetheless, ten City wells were maintained until 1988 as an emergency water supply (Figure 6). Four of the wells were sealed up in 1988 and 1989. Since the initiation of San Francisco water into the City system, the remaining six wells have been used very little for water production. The exceptions have been during a 1976 SFWD strike, and again during the summer of 1988 when the wells were used to supplement the City's water supply due to a reduction in water allocated by the San Francisco Water Department (Figure 7).

Several lessons were learned from operating the wells during the summer of 1988:

- The equipment performed well and the aquifer adequately responded to the pumping.
- Well operation and well water treatment is very labor intensive. Some normal field activities had to be sacrificed.
- Well operation reversed flows in portions of the distribution system, stirring up sediments and causing discoloration in the distribution system near the wells.
- During the period of full-scale operation (August and September) the wells were able to supply approximately 25 to 30 percent of City consumption.

A Report On The Condition Of The City Of Palo Alto Water Well System (Report) was prepared in early 1988 and the Report and its recommendations were approved by the City Council. The purpose of the Report was to review the adequacy of the City's ten wells.

Recommendations were made for improvements to four wells (Hale, Rinconada, Peers Park, and Meadows) and abandonment of four well sites (Park, Tower, Seale and Middlefield). The Park well was sealed in 1988 and the Tower, Middlefield and Seale wells were sealed in June, 1989. Further water quality evaluations on two wells (Matadero and Fernando) will be made prior to a final recommendation to abandon or improve them.

3.1.1.3 Santa Clara Valley Water District (SCVWD)

The City of Palo Alto, by virtue of its location in Santa Clara County and the existence of the City well system, is considered a Santa Clara Valley Water District retail water agency. Though Palo Alto does not directly receive water deliveries from SCVWD water treatment facilities, the District assesses a groundwater withdrawal charge (pump tax) when the City wells are used.

WATER FACILITY SITE LOCATIONS

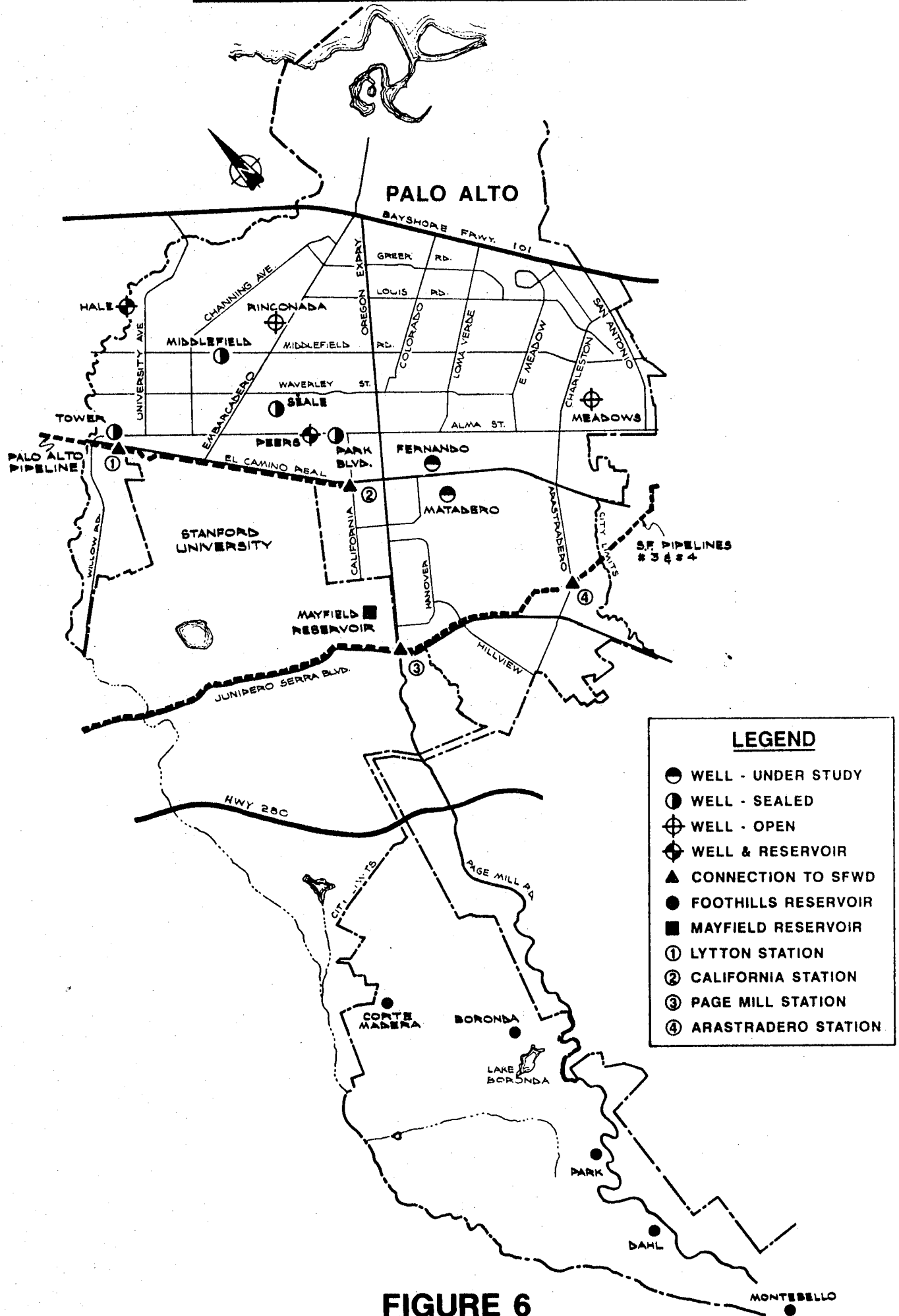


FIGURE 6

1988 Palo Alto Water Supply SFWD and City Well System

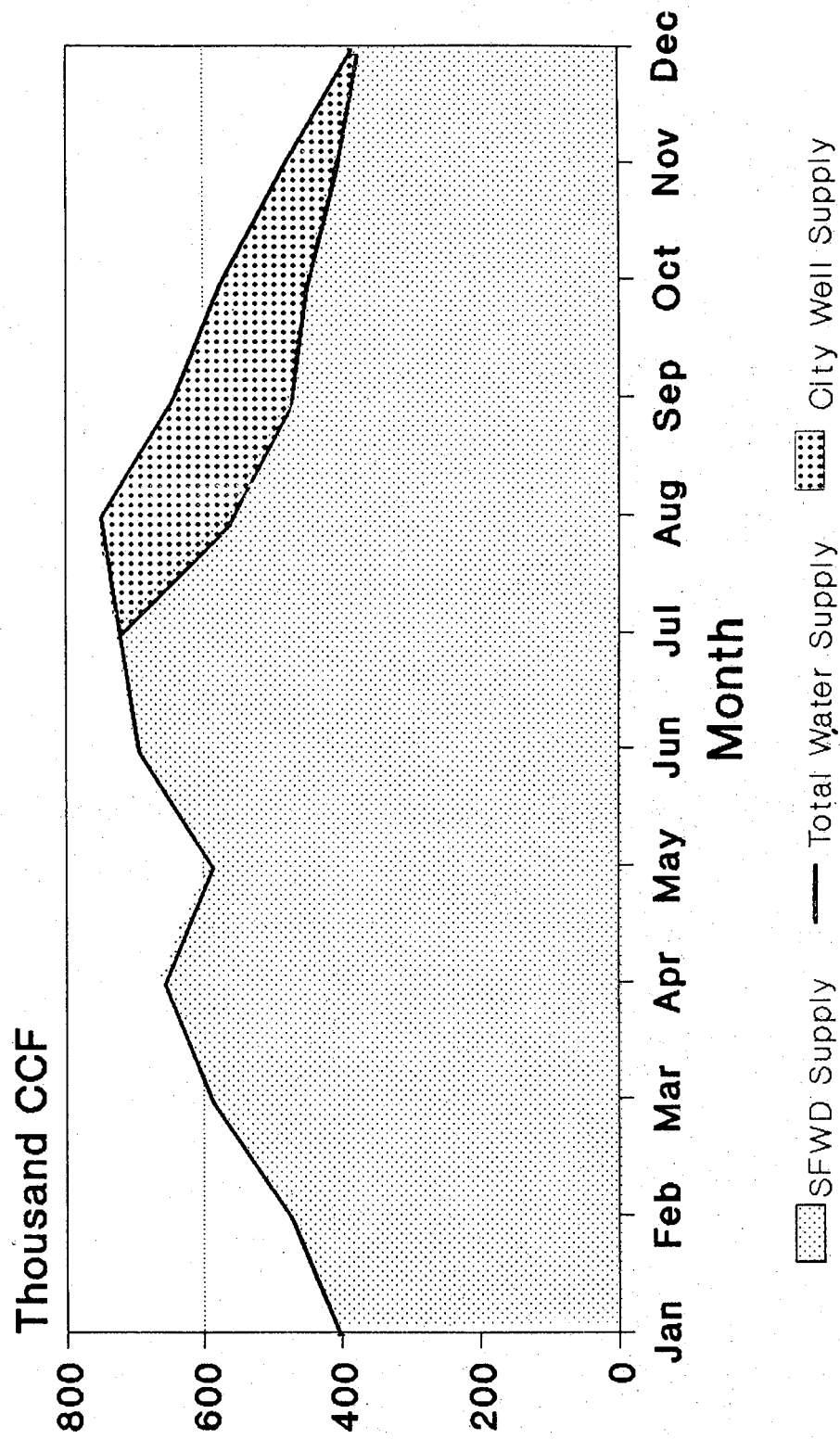


Figure 7

3.1.1.4 Reclaimed Water

Palo Alto's Regional Water Quality Control Plant (WQCP) has the ability to produce six MGD of reclaimed water. The City experimented with using the water to irrigate the municipal golf course but the high sodium absorption ratio threatened the turf and the course irrigation system was returned to potable water. Having learned from Palo Alto's experience, the City of Mountain View is blending potable water with the City's treatment plant effluent to irrigate its Shoreline Golf Course. Staff is investigating the feasibility of developing a similar system for the City golf course and/or the City parks.

Reclaimed water can also be utilized via water trucks. The City is currently using a truck to irrigate many street trees and staff is exploring the feasibility of converting this application to reclaimed or blended water. Additionally, CalTrans is using water from the WQCP to irrigate highway median strips.

3.1.2 Resources for the Future

3.1.2.1 SFWD: Near-Term Water Supply Situation

A. Peaking:

In the early to mid-1990's there exists the possibility that the SFWD water supply system will have difficulty in meeting peak flows during hot summer days when demand for water is greatest. The peaking problem will be caused by a "bottle neck" in SFWD water transmission facilities. There are only three pipelines that convey water from the foothills of the Sierras to the Bay Area. It is anticipated that in the coming decade, peak summer system demands will exceed the hydraulic capacity (325 MGD) of the three existing pipelines.

One solution is to construct a fourth pipeline. However, political and environmental groups in California may be opposed to this construction for various reasons. This option will need to be explored more closely in the 1990's.

Another approach which the SFWD is investigating is the addition of storage facilities in the suburban service areas that could be used to meet peak needs. In addition, individual water agencies may have to operate their own distribution and local storage facilities in order to meet local peak demands.

B. Filtration:

The U.S. Environmental Protection Agency (EPA) is contemplating a modification to the Safe Drinking Water Act (SDWA) which would require the filtration of all surface water systems, such as San Francisco's. The SFWD is opposed to the blanket application of the modification since their system meets or exceeds all existing standards without filtration. A

conservative estimate of the cost for filtration of SFWD water is \$200-\$300M. A decision is expected in late 1989, and implementation will be required by 1993.

The responsibility for filtration may lie either with the wholesaler (SFWD) or the retailers (SFWD and the suburban purchasers). In the event of the latter, Palo Alto would be required to build, operate and maintain treatment facilities. Either case implies significant capital expenditures.

3.1.2.2 SFWD: Long-Term Water Supply Situation

A. Bay-Delta Hearings

Currently, the State of California, through a series of hearings before the State Water Resources Control Board, is evaluating water flows, water rights, reservoir operation and return flows as a mechanism to address the Sacramento-San Joaquin-San Francisco Bay-Delta area's water quality issues. These Bay-Delta Hearings, as they have been named, consist of four phases to gather data and testimony about the water quality in the Bay-Delta and to determine how, perhaps, water rights might be adjusted in order to preserve the fragile ecosystem of the Bay and Delta. The Hearings are scheduled to conclude by the mid-1990's.

There exists the possibility that the State may modify SFWD's water rights on the Tuolumne River and/or require operation of the Hetch-Hetchy reservoir system such that more fresh water would flow into the Delta. Such operations could mean reduced or maintained (i.e., no allowances for increases) water deliveries to the customers of SFWD. In that Palo Alto is one of the largest wholesale customers of SFWD, this could have significant repercussions on the amount of water available to our customers.

B. Facilities Improvements

The 30 suburban purchasers account for two-thirds of the SFWD system consumption. Virtually all of the growth and increased demand for water will be in suburban purchaser's service territory as the City and County of San Francisco consumption is projected to be nearly flat into the next century. The long-term ability of SFWD to meet projected water demand may be dependent upon expansion of their existing facilities.

In order to meet the projected water demands into the next century, expansion of SFWD facilities will most likely need to take place (Figure 8). The realization of this expansion will depend upon two factors: SFWD's ability or desire to expand the system and overcoming the political and environmental forces that would oppose expansion of the SFWD system.

SFWD SYSTEM FORECAST

Historical and Projected

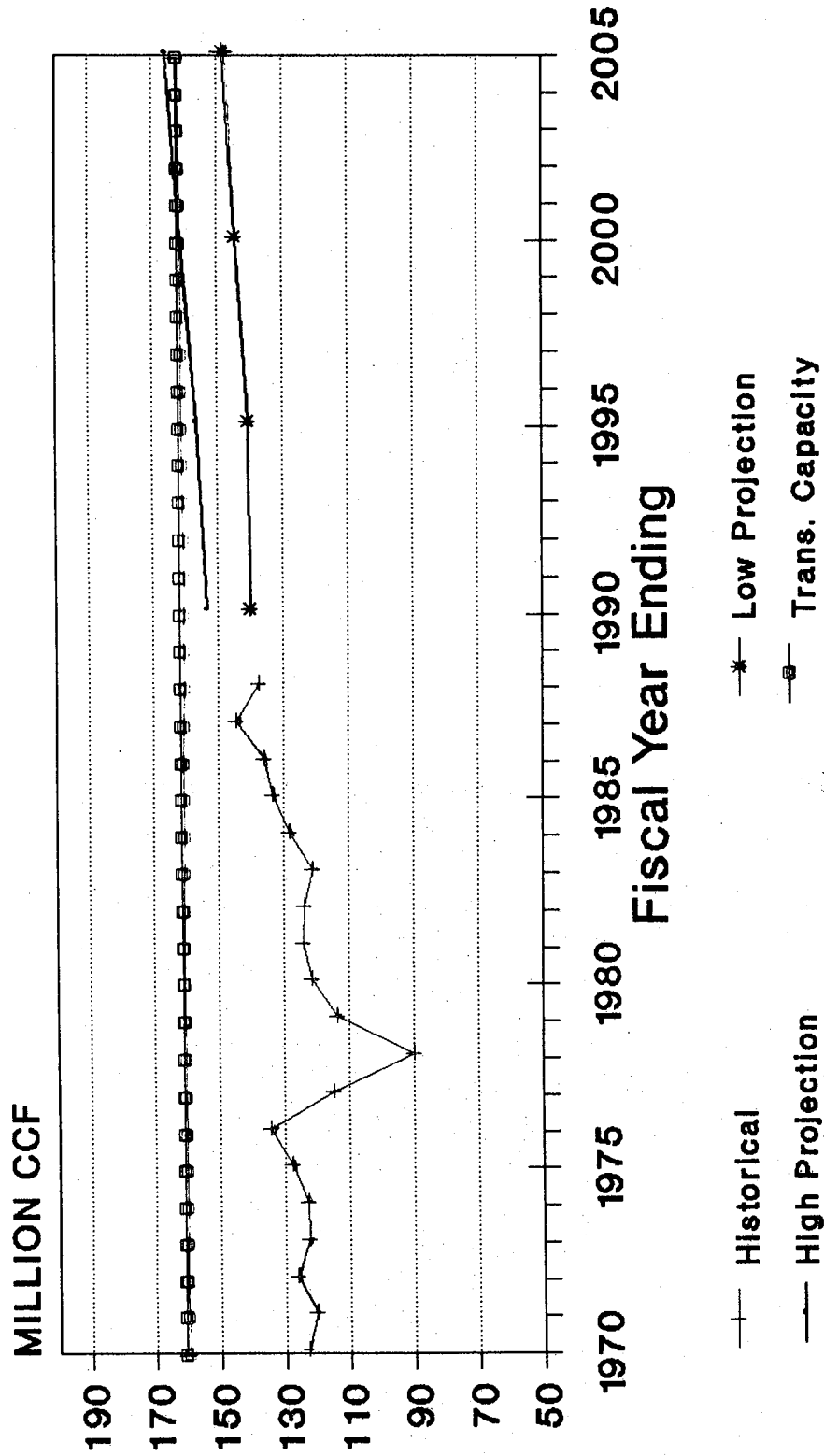


FIGURE 8

Source: SFWD

3.1.2.3 Wells

Though the City is relying on well equipment that is 31 or more years old, the wells have been maintained in good working order and produce water which meets drinking water standards. It is therefore appropriate to examine the feasibility of expanding their role in the Utility's supply mix. Depending on future demand, price and City policy decisions, the extent to which the wells are used could range from emergency only to full utilization.

Palo Alto is in an advantageous situation in that it has multiple sources of supply. As increasing demands challenge existing supplies, securing high quality water may be as difficult as securing adequate quantities. One possible response is the segmentation of the marketplace where higher quality water goes toward high quality uses (e.g., drinking water), and lower quality (including non-potable) water is supplied exclusively for lower quality uses (e.g., irrigation, building cooling). Such a scheme could be implemented in Palo Alto by using the wells for irrigating parks and other large turf areas. The extent of the implementation could range anywhere from irrigating the parks where two of the wells are located (Peers, Rinconada) to distribution throughout the City. The possibility of developing new wells will be examined.

3.1.2.4 Santa Clara Valley Water District (SCVWD)

Given the limitations of Palo Alto's contract with SFWD and the minimal possibilities for expansion of the SFWD system, SCVWD could be a future source of water. Alternatives for additional future water supplies carry with them several complicated issues. For example, the contract stipulates that Palo Alto cannot purchase water from any other supplier without the written permission of SFWD or without giving SFWD the opportunity to supply the additional water. In other words, SFWD has the first right of refusal as Palo Alto's primary water supplier. Staff will consider this contractual issue, as well as other issues such as cost, quality and quantity in future evaluations.

3.1.2.5 Water Reclamation

The use of reclaimed water can delay or eliminate the need for traditional additions to supply by replacing the use of potable water for certain water-intensive, low-quality applications. Examples of such applications include but are not limited to: irrigation, wetlands maintenance, cooling and processing, toilet flushing, and aquifer recharge. Use of reclaimed water in irrigation applications would offset potable water use in a summer peaking capacity while other applications would offset potable water use on a year-round basis.

Reclaimed water must generally be piped through a separate distribution system and the capital costs associated with the development of such a system are high. There are also public health concerns over exposure to reclaimed water. Nevertheless, dual supply and

distribution systems are operating successfully in several states. There are a number of large systems operating in southern California, and there are some smaller applications here in the Bay Area.

3.1.2.6 United States Geological Survey Groundwater Study

The United States Geological Survey (USGS), responding to a request by the City of Menlo Park, is proposing a study of the groundwater aquifers in eastern San Mateo County and northern Santa Clara County. Currently, data regarding the hydrogeology, water quality and characteristics of the aquifers in this area is incomplete. The objectives of the regional study are to define aquifer properties, the quality of groundwater and the potential for local groundwater development. The potential benefits would allow prudent long- and short-term development of groundwater for potable and non-potable uses, and identification of effects of urbanization on recharge and contamination of groundwater. The proposed study would be complementary to a study already underway in the City and County of San Francisco.

The scope of work, study boundaries and participants in the study have not been defined, nor has the total cost. These items will be defined in project meetings that are proposed to be held in the fall of 1989 with the project scheduled to start in the fall of 1990. The participants in this proposed study would be expected to fund one-half of the study costs with the USGS funding the remaining half.

3.1.3 Recommendations

1. Maintain leadership role in the Bay Area Water Users Association.
2. Refurbish the wells that are recommended to remain in the water system and maintain them in a condition and manner consistent with their intended use.
3. Continue working with the SFWD and the Bay Area Water Users Association Planning Committee to address contractual issues and to study the feasibility of facilities that may alleviate the peaking problem.
4. Evaluate the operational feasibility of using existing City storage and distribution facilities for water supply during peak periods.
5. Closely monitor the proposed modification to the Safe Drinking Water Act.
6. Monitor and participate in the Bay-Delta hearing process.
7. Perform a study of Palo Alto's anticipated supplemental needs in order to prepare for the situation when the SFWD system reaches full capacity.

8. Analyze the feasibility of developing new wells.
9. Continue working with the SCVWD staff and examine the feasibility of interconnecting with the SCVWD for future treated water deliveries.
10. Analyze the feasibility of using reclaimed water as a source of supply for certain applications.
11. Support and participate in the proposed United States Geological Survey groundwater study.

3.2 Demand-Side Resources

Demand-Side Management (DSM) can be a significant source of additional water supply for the simple reason that water conserved by current users becomes available for new users and uses. This conserved water supply is of higher quality than alternative supply sources such as groundwater or imported water. Further, using this supply is environmentally sound and avoids the political problems associated with most new water supply projects.

The life-cycle cost to the utility of a well-designed DSM program is lower than the cost of securing additional water supplies, especially under a likely scenario of increasing competition for limited water resources. By analyzing consumption patterns and both customer and utility needs, a variety of DSM activities can be designed that assist in enabling Palo Alto to continue to serve its customers high quality water.

DSM encompasses a wide range of activities, programs and services designed to increase water use efficiency, reduce overall water use and influence when water is used. Promotional and educational programs, financial incentives, direct installations, guidelines, regulations and strategic rate setting as well as drought/ emergency planning are examples of DSM.

The flexibility of DSM is one of its greatest assets. Levels of DSM efforts - and the resulting water use impacts - can be adjusted quickly to accommodate uncertainty and rapid change in load growth, weather conditions and availability and price of other supply sources. By contrast most other supply sources do not offer such flexibility because of contract restrictions, construction lead times and investment commitments. Some disadvantages associated with using DSM as a source of supply include reliability and acceptability. The Utility loses a level of control when the source lies in the individual customer's use patterns--and therefore loses a level of reliability. Additionally, DSM programs are successful only to the extent that they are embraced by the customer. Programs designed to elicit significant behavior modification or introduce new or unfamiliar technologies may meet with customer resistance.

As a result of the current water shortage, staff has developed water conservation informational resources for residents and businesses and regulations to guide the City towards maximally efficient landscape water use.

3.2.1 Existing Resources

3.2.1.1 Water Rate Design

Among a variety of ratemaking criteria common to the industry, the criteria of promoting the efficient use of service is perhaps allowed to influence Palo Alto's rate design to a greater extent than prevails with other California water utilities. This is evidenced by the fact that Palo Alto is among a small minority of California water utilities that incorporates an inverted rate structure in its rate design. An inverted rate structure provides that higher prices are charged for higher usage levels and is sometimes referred to as a "conservation oriented" rate design.

Palo Alto provides water service to customers under a rate schedule which consists of a monthly service charge based on the customer's meter size and a schedule of six consumption rate blocks with ascending prices for higher usage levels. The initial rate block provides a minimum "baseline allowance" of 400 cubic feet priced at the lowest commodity rate. This form of rate structure was introduced in 1976, in part to promote the efficient use of water. Then, as well as today, most utilities in California employed a descending water rate structure which provides for lower prices as consumption rises. The City has viewed this declining block rate structure to be inefficient in this era of decreasing natural resources and high marginal costs to procure additional water resources. Thus, it is likely that the inverted rate structure will continue as the rate design of choice for Palo Alto in the future.

In addition, in 1988 Palo Alto introduced a "Water Rationing Plan" rate schedule. The schedule can be made effective at the discretion of the City Council in the event of a serious water shortage. The plan is based on specific reductions by Palo Alto residential and non-residential users. It provides financial penalties in the event a customer exceeds his or her allocation as well as a process to allow for exemptions. It is likely that this rate schedule will be modified in the future as conditions change.

3.2.1.2 School Programs

Working with teachers and school children at all grade levels is an ideal way to both affect the water practices of Palo Alto families today and develop a group of future Palo Alto adults who understand and apply conservation principles. Activities include classroom presentations, curriculum development, teachers work-shops, the use of Michael The Mastermind computer program and a teacher's information reference library.

3.2.1.3 Information Outreach

The Utilities Department should serve as a resource library and clearinghouse of the latest information on specific water conserving technologies and techniques applicable to each customer class. Home and business on-site consultations as well as workshops and seminars will continue to be used to provide direct, targeted assistance. The City will continue to facilitate bringing customers together to learn from each other, particularly among commercial customers with complex end uses.

A key to effective outreach is working with existing industry and community networks and groups to leverage staff and budget resources to the greatest extent possible. Coordination with product and service suppliers (e.g. hardware stores, nurseries, or landscape and building architects) is another effective way to leverage City efforts.

3.2.1.4 Research and Analysis

The decision to pursue many DSM activities -- particularly those involving direct payments to customers (e.g. rebates, financing, retrofits, etc.) -- must be based on an analysis of the nature and market penetration of specific water end uses, as well as customer receptivity to the program. In other words, will the program work? How effective will it be? At what cost and to whose benefit? These questions will be answered through studies of water consumption, research, analysis and modeling.

3.2.2 Resources For The Future

3.2.2.1 Demonstration Sites

The City's facilities and parks make ideal locations to install and publicize the latest in cost-effective indoor and outdoor water management technologies and practices. Such demonstration sites educate customers about available options, provide evidence of the feasibility and effectiveness of the actions taken and display the City's commitment to water management.

Residential and commercial customers who have taken conserving actions can be another good source of demonstration projects to educate their peers.

3.2.2.2 Reward and Recognition

Recognition programs can be used to motivate continued water management efforts as well as publicize customer achievements. Such programs can range from congratulatory notices sent to customers to formal award events. Examples include tours of locations where water-conserving landscapes have been installed, and plaques or signs given to businesses that achieve certain water reduction targets. Rewards need not be expensive or complex to be effective.

3.2.2.3 Establishing Regulations

New construction, major remodeling and the sale of properties present opportunities for the City to require installation of water-conserving devices and systems. Since irrigation is one of the largest single water uses, regulations guiding the type of plantings and irrigation systems that are installed can be particularly effective. Staff is in the process of establishing such regulations with extensive input and cooperation from affected parties, including the Architectural Review Board, Stanford Land Management and the local "green" industry. The regulations, in the form of an ordinance, are expected to go before Council for approval in the fall of 1989.

In regard to indoor water use, high efficiency showerheads, low flush toilets and faucet aerators are basic devices that affect major areas of consumption. Current City regulations require certain devices be installed in new construction. In addition to device requirements, regulations mandating water re-use capabilities will be evaluated.

3.2.2.4 Promoting Direct Action

The highest penetration rates of water management technologies come from programs that either provide the devices themselves, offer installation, give financial incentives, regulate activities, or mandate specific actions.

Examples of programs include rebates for specific water-conserving devices, free distribution of products, installation services, direct loans or assistance in obtaining financing and cooperative efforts with product retailers. Such programs would be evaluated annually for cost-effectiveness and appropriateness.

3.2.2.5 Strategic Pricing

The City's water rate design is influenced by a number of ratemaking objectives, including but not limited to promoting the efficient use of water. In that such promotion is also a goal of DSM programs, rate structures which reward efficiency are considered as a DSM strategy.

The City's current inverted rate structure, which imposes higher rates for increased water use, encourages conservation. One innovative rate structure which may become cost-effective in the future is time of use rates. If the cost of water from the SFWD increases to reflect peak summer usage, the City will consider time of use rates.

Another innovative rate strategy to evaluate is charging an additional price increment at the highest tiers for each customer class. The revenue from this additional price increment could be used for the purchase of water management devices. The devices or incentives might then be provided to those same customers who use water at the highest tier levels.

3.2.3 Recommendations

12. Continue to pursue demand-side programs for the purpose of promoting efficient use of the City's water resources.
13. Continue to examine the rate design in terms of effectiveness in meeting the principal criteria employed by the City, and perform timely comprehensive cost of service studies.

4. OPERATIONS

The water utility is responsible for providing safe and reliable distribution of water for residential, industrial and commercial customers, as well as fire protection and municipal uses in an economical, efficient and environmentally sound manner. To meet this responsibility, a number of operations and maintenance activities must be performed on a regular ongoing basis.

4.1 Operation and Maintenance of Water Delivery and Storage Systems

4.1.1 San Francisco Water Department Connections

There are four connections to the San Francisco Water Department (SFWD) pipelines where Palo Alto's water distribution system receives its potable water supply. These are shown on Figure 6 as the Lytton, California, Page Mill and Arastradero Stations.

The pressure regulating valves and fluoridation equipment at these stations are inspected every other day. The regulating valves are overhauled every three to four years. Repairs at the connection facilities are performed on an as-needed basis with no preventative maintenance program due to current staffing levels. A consultant has been selected to make recommendations relative to updating the water receiving stations and the related monitoring systems.

4.1.2 Wells

The top four producing wells were fitted with chlorine and fluoride injection pumps and were operated continuously during the summer of 1988. In spite of the 31 year-old equipment and past maintenance on a "as-needed basis" these four wells were able to pump sufficient water, in combination with strong conservation, to avoid any penalties from the San Francisco Water Department.

During normal years the wells are test-pumped three or four times a year. All repairs are on an as-needed basis. As was discussed in Section 3.1.1.2, these four wells have been recommended for refurbishing to maintain them in good operating order.

4.1.3 Reservoirs

Reservoirs located in the City's higher elevations are operated on a continual basis from April through November. In November, the reservoirs are filled, and the booster pump stations are secured for the winter (due to minimal demand during this period). In March, the water which has been stored during the winter months for emergency purposes is drained back into the system. The reservoirs are then refilled for use during the summer

months. Repairs at the reservoir facilities are performed on an as-needed basis. The five foothills water reservoirs are currently undergoing internal recoating and seismic protection improvements.

4.2 Water Quality

4.2.1 Water Quality Monitoring

As the water wholesaler, the San Francisco Water Department is responsible for verifying that the raw water sources and the treated water at their treatment facilities are in compliance with the Safe Drinking Water Act (SDWA). To that end, a complete analysis of general mineral, metal, and nitrate concentrations of all water sources is conducted at least annually by SFWD. Herbicides and pesticides are checked at least every three years and radioactivity is tested every four years. In addition, SFWD checks the turbidity of all treated water on a daily basis.

As the water retailer, Palo Alto is currently responsible for monitoring color, odor, turbidity, chlorine residual, temperature, conductivity and pH on a monthly basis, and fluoride and bacteriological quality weekly at representative customer taps.

As mentioned earlier, four of Palo Alto's wells were used continuously during the summer of 1988. The State Department of Health Services (DOHS) now considers these four wells to be source wells so they must be tested as such. See Table 2 for details of the monitoring program.

4.3 Operation of the Distribution System

4.3.1 Main Flushing

Water mains throughout the City are flushed on an annual basis, except in drought years. The process of flushing the entire distribution system is performed within a one-week period. Fire hydrants are opened in order to flush out any sediment which may have collected during the winter months when water usage is low. An estimate is made of the quantity of water used in this process and, therefore, is not a part of the losses or unaccounted for water. Average annual losses for fiscal year 1987-1988 were 7.1 percent, well below the American Water Works Association (AWWA) standard of 10 percent.

TABLE 2**MONITORING PROGRAM FOR
PALO ALTO WATER SUPPLY**

ITEM MONITORED	WHERE SAMPLED	FREQUENCY	TESTING AGENCY
GENERAL MINERALS -- iron, magnesium, manganese, calcium, foaming agents, pH, sulfate, sodium, conductivity, hardness, alkalinity	Sources	Yearly	SFWD
	Active Wells	Yearly	Palo Alto
INORGANIC CHEMICALS -- metals and nitrate	Sources	Yearly	SFWD
	Active Wells	Yearly	Palo Alto
ORGANIC CHEMICALS -- pesticides and herbicides	Sources	Every 2 Years	SFWD
	Standby Wells	Every 2 Years	Palo Alto
	Active Wells	Every 2 Years	Palo Alto
TURBIDITY	Sources	Daily	SFWD
RADIOACTIVITY	Sources	Every 4 Years	SFWD
	All Wells	Every 4 Years	Palo Alto

Table 2, continued

ITEM MONITORED	WHERE SAMPLED	FREQUENCY	TESTING AGENCY
GENERAL PHYSICAL -- color, odor, turbidity	Customer Taps	20/Month	Palo Alto
FLUORIDE	Customer Taps	20/Week	Palo Alto
BACTERIOLOGICAL	Customer Taps	30/Week	Palo Alto
	Water Quality Control Plant	2/Week	Palo Alto
CHLORINE RESIDUAL	Customer Taps	20/Month	Palo Alto
	Water Quality Control Plant	5/Week	Palo Alto (when wells running)
TRIHALOMETHANES	Distribution System	8/Quarter	Palo Alto (when wells running)
		4/Quarter	Palo Alto
		2/Quarter	SFWD

4.3.2 Backflow Prevention

Title 17 of the California Administrative Code requires having staff assigned to investigate potable water/wastewater cross-connection problems. Responsibilities include continually surveying the water system for cross-connection potentials, and maintaining and enforcing the cross-connection program. The City's cross-connection program has been approved by the State and the system survey is underway.

4.3.3 Water Valve Operation

Of the 3,900+ water main valves, approximately one third are inspected and exercised annually. This does not meet AWWA standards that all valves within a water distribution system be inspected and operated annually. Valves found to be non-functional are replaced on an as-needed basis based on available staffing.

4.3.4 Water Meter Testing and Calibration

There are 16,500 residential meters in the system of which approximately 1,200 are repaired and replaced annually. This represents a replacement cycle of approximately 14 years, equivalent to the AWWA standard. In addition, 127 large water meters are inspected and tested annually to assure accurate registration. Calibration and repair of large water meters is performed on site.

Staff is investigating the cost effectiveness of large meter repair and replacement, including field procedures and test cycles.

4.4 Maintenance of Distribution System

4.4.1 Main Replacement

Water distribution system maintenance has historically been adequately staffed to deal with the approximate 20 main breaks and 30 service replacements that were occurring in any given year. However, trends over the last three years have shown a steady increase in the number of water main breaks with an all-time high of 27 breaks repaired in the first six months of fiscal year 1988-89. Analysis of the pipe indicates that over 65 percent of the breaks were due to corrosion of cast iron mains installed prior to 1945. Presently, an inordinate amount of employee overtime is being used for emergency response and repair.

Although an accelerated water main replacement program was begun in 1986, there is a strong concern from a maintenance point of view that if the replacement program is not further accelerated, system reliability is going to be difficult, if not impossible, to maintain. The current program is a 100-year replacement cycle, based on present staffing. An in-house study is in progress to determine the condition of the distribution system and recommend a more appropriate program.

Future operations and maintenance programs such as valve replacement, fire hydrant upgrades and flow testing will have to be deferred, given the current effort required to maintain the system mains. As the distribution system continues to age, required maintenance will increase until, at the current level of staffing, system reliability may be compromised.

Water Utility field operation and maintenance programs should be reviewed to insure that present service levels are maintained and to enable control over planning and scheduling of work loads.

4.4.2 Valve Replacement

The valve replacement program has been postponed due to the reallocation of staff required to repair the water main lines. Original plans called for repair or replacement of broken valves as soon as possible after discovery. Currently, only the valves that actually leak are repaired or replaced. The backlog of broken valves is 47 and growing.

4.4.3 Booster Pump Stations

All six sites are inspected weekly; pumps at these stations are tested bi-annually. Associated regulating valves are overhauled on an annual basis and repairs at the pump facilities are performed on an as-needed basis.

4.5 Emergency Plan

An Emergency Operations Plan outlines a procedure for reacting to a disaster which seriously damages or destroys a part of the water utility system.

An Emergency Operations Plan normally consists of a list of anticipated emergency-caused effects on the system, an estimate of remaining capabilities, an estimate of required system demand, an estimate of the system's ability to meet the demand, specified priorities of the system, the preferred methods of using available resources and assignments for available staff.

Palo Alto is located in the highest seismic risk zone (Zone 4) as defined by the AWWA Seismic Risk Zone Map. (The zones range from zero to four, indicating no damage to extreme damage to water facilities as a result of an earthquake). In the event that supply from SFWD is interrupted, the remaining six City wells could supply a population of 60,000 with ten gallons per capita per day, an accepted industry standard. Additionally, the City could, in the event of such an emergency, connect with Stanford and Mountain View.

A critical element of a comprehensive emergency plan is pre-planned communications procedures which keep key staff in contact with decision-makers and each other, and ensure all customers get reliable, complete, and useful information and instruction quickly and continuously.

The current Water Utility Emergency Operations Plan is outdated and needs significant revision in order to meet current AWWA standards.

4.6 Recommendations

14. Proceed with the current plans on the reservoirs improvement project to provide improved seismic integrity and corrosion protection.
15. Proceed with the study regarding recommendations for updating the receiving stations and the related monitoring systems.
16. Continue the development and implementation of a comprehensive large meter maintenance program.
17. Re-evaluate staffing levels to insure adequate ongoing preventative maintenance involving valve replacement, meter calibration and replacement, fire hydrant upgrades and flow testing.
18. Proceed with the in-house study regarding the appropriate main replacement cycle.
19. Update the Water Utility Emergency Operations Plan to meet current industry standards.

5. CONCLUSION

The Water Utility Plan is intended to provide an overview of issues and concerns facing the Utility. Additionally, the Plan is designed to serve as a guide to Utility planning in an uncertain future. The strategies and tactics outlined in the Plan are intended to be flexible, such that future circumstances will not jeopardize the integrity of the Plan.

Implementation of the strategies and tactics will take place over a period of time. Therefore, many recommendations will require further study to determine detailed courses of action and/or the necessity of the measure.