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PROJECTED M&I DEMAND IN THE LADWP SERVICE AREA 1990-2010

by

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Our analysis of urban water use in the LADWP service area is based on two sources: LADWP's demand projections in its Urban Water Management Plan (UWMP) of November, 1990, and projections carried out for the entire service area of the Metropolitan Water District (MWD) by Planning & Management Consultants, Inc. (PMC) using the so-called MWD-MAIN Model, published in June, 1991. The MWD-MAIN model breaks out the LADWP service area as one of its geographical subareas.

Although they form their forecasts in different ways, both studies adopt a similar approach to the calibration of their models: they both take 1980 as the base year, and forecast water use in 1985, 1990, 1995, 2000, 2005, and 2010, using the data from 1985 to both verify the model and supplement its calibration. The PMC report explains that 1980 was selected as the base year because, at the time the analysis was being conducted, it was the most current year for which disaggregate socioeconomic data were available, based on the 1980 Census. For later years, both studies drew on demographic projections made by the Southern California Association of Governments (SCAG) for its Regional Growth Management Plan of February 1989. Given these demographics, demand is forecast on a per capita, per household, or per account basis.

Both models adopt some form of an end-use approach to demand forecasting: that is, they disaggregate M&I use into its major components and then forecast each component separately. As Table 1 shows, the disaggregations used in the two studies are similar, but do not match exactly. MWD-MAIN makes separate, regression-based, forecasts for single-family and multi-family residential uses, for commercial use and for industrial use; the remaining category -- "other" (governmental, public, outdoor and unaccounted) -- is forecast as some percentage of the total of the other four components. LADWP-UWMP develops separate forecasts for single-family and multi-family residential uses, for commercial, industrial and governmental uses combined, and for unaccounted losses.

The MWD-MAIN report presents three sets of forecasts, reproduced in Table 2. The first set of forecasts, labelled "Base Water Use," is intended to represent what it is believed would happen to water use within the LADWP service area if there were *no* trend towards conservation over the period 1980-2010, and the only shift in demand came from demographic trends over that period, including the anticipated changes in population, household size, household income, housing mix and employment mix. A shift in the mix of industrial employment towards less water-intensive industries and an increasing share of multi-family housing units in the total housing stock work to reduce per capita M&I use. On the other hand, a shift in the mix of commercial employment towards more water-intensive industries, a trend toward a decreasing household size (i.e. more homes with fewer occupants per household), and a gradual increase in real income per household all work to raise per capita M&I use, with the net effect being a 13.4% increase in per capita consumption between 1980 and 2010.

The second set of forecasts, labelled "Water Use With Conservation," adjusts the Base Water Use forecasts to allow for the effects of two sets of conservation factors: the 1980 California Plumbing Code, and increases in the retail costs of water supply and sewer service. The Plumbing Code required that, starting in 1980, all toilets, showerheads and faucets sold in California would have to meet new efficiency standards; for example, toilets would be held to a maximum of 3.5 gallons per flush, compared to 5.0 gpf previously. These new standards affected all new residential, commercial and industrial structures constructed after 1980; they would also affect plumbing fixtures in pre-1980 structures at such time as they are replaced post-1980. Both effects were estimated and factored into the MWD-MAIN forecasts.

With regard to price changes, the MWD-MAIN model has non-zero price elasticities of demand for each of the four components of M&I use. Over the period 1980-1990, the retail price of water and sewer service in the LADWP service area rose, in real terms, by 63.6% for residential users and 19.6% for commercial and industrial users, due to increases in both MWD's wholesale water rates and LADWP's other costs of operation. The effects of these price increases were factored into the demand forecasts. With respect to the period after 1990, the MWD-MAIN study assumes that -- in real terms -- there will be no increase in local water and sewer utilities' costs of operation *except for* an increase in MWD's wholesale rates; for LADWP it was estimated that this would raise real prices for all customer classes by a little under 23% over the period 1990-2010. This explains why the pace at which conservation reduces base demand slows down considerably in the forecasts after 1990 (these conservation savings amount to 45,684 AFY over the period 1980-1990, compared to 33,049 AFY over the period 1990-2010).

The third set of forecasts labelled "Water Use with BMP" throws in additional conservation expected to occur post-1990 (hence the forecasts for 1985 and 1980 are the same as those presented under Water Use With Conservation). BMP refers to the set of Best Management Practices which all the major California urban water utilities, including LADWP, have committed themselves to implement over the next five years. These include programs such a residential retrofit of showers and toilets, toilet retrofits in public and governmental buildings, home water audits, leak detection and audits of water agency distribution systems, large landscape audits, and landscape requirements for new multifamily, commercial and industrial complexes. The other change, in addition to the BMP's, is the 1992 California Plumbing Code, which requires that more efficient toilets (1.6 gallons per flush) be installed in all new construction and in remodelled units requiring a building permit after January 1, 1992. Between 1990 and 2010, the 1992 Plumbing Code is forecast to reduce M&I use within the LADWP service area by 12,045 AFY, and the other BMP's are forecast to reduce it by an additional 29,822 AFY.

For the purposes of our analysis, the relevant MWD-MAIN forecast is the third set -- Water Use with BMP. Since LADWP is committed to implementing the BMP's and the Plumbing Codes are a legal reality, the assumptions underlying these forecasts come closest of the three forecasts to characterizing the actual conditions that can be expected to prevail over the period 1990-2010.

Table 3 presents the LADWP-UWMP forecasts of M&I demand (because of rounding errors, some of these figures differ from those appearing in the LADWP report in the third or fourth digit). For the purposes of developing its estimates, the LADWP study takes base demand in 1980 to be 180 gpcd, as compared to 186.2 gpcd in the MWD-MAIN study (actual M&I use in the LADWP service area was about 172 gpcd in fiscal year 1979-80 and 182 gpcd in fiscal year 1980-81). To this base, the LADWP study adds estimates of a net increase in demand due to demographic changes plus a general growth trend, which raises overall M&I use by 4.9% over the period 1980-2010 to a level of 188.8 gpcd (as compared to 211.1 gpcd in the MWD-MAIN model). The study then factors in the effects of various existing and presently anticipated conservation programs affecting indoor residential and CIG (commercial/industrial/ governmental) uses, outdoor uses, and unaccounted losses (other); these reduce forecast M&I demand in 2010 to 174.2 gpcd (as compared to 183.1 gpcd in the MWD-MAIN forecast of Water Use with BMP). The LADWP study accounts for the 1992 Plumbing Code and many of the conservation activities that were subsequently included in the BMP's. However, it does not account for certain other conservation programs that are identified as having some potential but have not yet been adopted or implemented; those include requiring the replacement of existing toilets with ultra-low-flush fixtures on the sale of property, requiring separate water meters for individual units in new, multi-family construction, legislating minimum water use efficiency standards for dishwashers and clothes washers, offering financial incentives for conservation to large industrial or commercial customers, and imposing a "no net gain" policy on new development.

In evaluating these models, it is instructive to start by reviewing the forecasts for the period 1980-90 -- essentially, the calibration period. Starting with the MWD-MAIN model, the forecasts tell a story of very dramatic change over this decade. Between 1980 and 1985, demographic trends are projected to increase per capita M&I demand by 4.9%; the change is even more pronounced for residential demand, which is projected to grow over these five years by more than 10% in the case of single-family units, from 384 to 424 gallons per unit per day, and by almost 13% for multi-family units, from 228 to 257 gpud. By contrast, in the five years from 1985 to 1990, the effects of the 1980 Plumbing Code and retail price increases for water and sewer services are projected to reduce single- and multi-family demand by 10.5% and 6.7%, respectively, and to reduce overall per capita M&I demand by 6.5%, from 193.1 to 181.2 gpcd. These are enormous changes -- far larger than is projected to occur in any other quinquennium or decade. Frankly, it strains credulity that M&I demand could grow so much -- or contract so much -- in five years.

Although less pronounced, the LADWP-UWMP model also projects some changes between 1980 and 1985 which are hard to believe. Here, the pattern of change is somewhat different: while overall residential base demand hardly changes at all during those five years, the study projects a substantial increase in baseline multi-family use and, simultaneously, an offsetting reduction in single-family use. Both changes are much larger than anything projected to occur over the subsequent 25 years.

Because of the gyrations in their forecasts for 1980 and 1985, there are quite substantial differences in the models' projections of aggregate M&I use and, especially, of the individual use components in those two years. By 1990, however, the models begin to converge, albeit from different directions. Table 4 presents a comparison of the MWD-MAIN and LADWP-UWMP forecasts for 1990 with actual consumption in fiscal year 1989-90 as reported by LADWP. In both cases, the forecast of aggregate M&I use is very close to actual demand -- within about 1%. This is not surprising because both forecasts were being prepared around 1990, and one would expect the models to be calibrated so that they project current demand fairly well. Of greater interest is the distribution of aggregate demand among the individual components. Both studies underestimate single-family and multi-family residential to a small degree; this is probably explained by the fact their forecasts are for normal weather conditions, and 1989-90 was somewhat warmer than average. With the other components of demand, however, the errors are more pronounced. The MWD-MAIN model, in particular, appears to over-estimate both commercial and industrial demand by more than 30%; this is offset by under-estimating governmental use and unaccounted losses to roughly the same degree. While less pronounced, something similar happens with the LADWP-UWMP analysis: commercial/industrial/governmental uses are overestimated, while unaccounted losses are underestimated.

Table 5 compares the two sets of forecasts of M&I use in 2010. These are based on similar forecasts of the 2010 LADWP service population -- 3.849 million versus 3.875 million -- so that any difference in the forecasts reflects differences in projections of per capita, per unit or per employee use. The MWD-MAIN forecast of aggregate M&I use is 4.4% higher than the LADWP-UWMP forecast.

For the purposes of our own analysis, we are inclined to follow the LADWP-UWMP projections for 1990-2010 rather than the MWD-MAIN projections, for two reasons, First, as already noted, the LADWP-UWMP projections start off in 1980 at a level which is closer to actual M&I use in that year than the MWD-MAIN projection (180 gpcd versus 186.2 gpcd). Second, the MWD-MAIN projections of residential demand then grow between 1980 and 1985 and decline between 1985 and 1990 in a manner that we consider implausible. These changes are driven by two economic variables in the regression equations for single- family and multi-family demand: home value and retail water/sewer price. Starting with home value, between 1980 and 1985 household income in the LADWP service area rose in real terms by 21%; this change is then translated into a change in home values, based on a pooled cross-section/time series regression equation of home value on income; the projected change in home value over the period 1980-85 is then translated into an increase in the residential demand for water, based on a pooled cross-section/time series regression linking residential water use to home value. The result is a projected increase in residential water use of 10% for single-family units and 13% for multi-family units over the period 1980-85 -- an amazing increase in such a short time. Conversely, it is the real increase in retail water prices in the LADWP service area which causes the reduction in M&I use over the period 1985-90, operating through price elasticities estimated in the pooled cross-section/time series regression of residential water use.

With respect to the period after 1990, the main factor causing the two sets of projections to diverge is the rising trend in home values -- retail water/sewer service prices are not an issue now because the MWD-MAIN model makes the assumption (not necessarily a plausible one) that these prices will not increase in real terms after 1990. However, it does assume that home values will increase in real terms over the period 1990-2010 and that this will increase residential demand. In the LADWP service area, the MWD-MAIN model projects that the real increase in home values over this period will add 9,102 AFY to single-family residential demand and 21,363 AFY to multi-family residential demand in the year 2010. Without these increases, much of the difference between the MWD-MAIN and LADWP-UWMP forecasts would vanish.

We suspect that much of this increment in demand is illusory. That is to say, we are concerned that the price and home value elasticities are inaccurate for the purpose of forecasting inter-temporal changes in demand. Although the MWD-MAIN regression equations were estimated from pooled time-series/cross-section data, these elasticities may be reflecting cross-section effects more than time-series effects. This may be especially true of the elasticities of demand with respect to home value. We can certainly imagine a cross-section connection between the value of a dwelling unit and the level of residential water use -- houses with a higher market value might well have more water using appliances, larger lots, and more elaborate landscaping. But, in a time-series context, we regard it as much less likely that increases in home value associated with a booming real estate market and growth in personal income will induce a substantial change in residential water use in existing housing units.

This is not to say that we regard the LADWP-UWMP projections as perfect. One questionable feature, in particular, is the projected breakdown of population between single-family and multi-family residences. The LADWP-UWMP report states that multi-family units account for 59% of the total number of dwelling units in 1989 (see page 3-10); by contrast, MWD-MAIN assumes that they account for 56.7% in 1990. Furthermore, LADWP-UWMP assumes that all of the growth in service population after 1990 is housed in multi-family units -- the population residing in single-family units is frozen at 1,730,000 between 1990 and 2010. By contrast, the MWD-MAIN study assumes that there is some increase in the number of single-family dwelling units over that period, although multi-family units account for 89% of the increment in housing stock after 1990. Since per capita residential consumption is significantly lower in multi-family than single-family dwellings, to the extent that LADWP-UWMP might have overestimated the share of the population residing in multi-family units this would make its projection of aggregate residential demand somewhat too low.

With these caveats, we will take the LADWP-UWMP demand projections in the last row of Table 3 as our best estimate of future M&I demand in the LADWP service area. We recognize, however, that other estimates are possible, and we will briefly discuss some potential adjustments to these projections to allow for the effects of change in weather, changes in population, and additional conservation.

In order to investigate the effects of changes in weather on M&I demand in the LADWP service area we estimated time series regression models for the various components of M&I use, using monthly data for the period July 1985 - December 1990. Throughout almost all of this period, multi-family demand was reported in a category which combined it with commercial demand. Hence, those two categories are combined in a single regression equation. The other regression equations were for single-family residential demand, for industrial demand, for non-governmental irrigation customers, for three types of governmental demand, and for total M&I demand as an aggregate. The explanatory variables in each case were monthly precipitation and average daily temperature at LA Civic Center, together with lagged values of those variables. The equations for single-family residential, combined commercial and multi-family residential, and total M&I demand are shown in Table 6; it is clear that the climate variables have a significant effect on demand for these components of M&I use. The same is true, also, for irrigation use and much of governmental use (which, indeed, involves irrigation of parks, school playing grounds, etc). For industrial use, however, the climate variables had an extremely small effect -- almost zero, for practical purposes.

To quantify the impacts of hot weather, we used all of these regression equation to simulate the monthly levels of water use in fiscal year 1990 that would be associated with normal temperatures in Los Angeles versus the maximum temperature observed, using the period 1944-1990 to define both variables. Table 7 lists these temperatures together with the actual temperatures that were experienced during fiscal year 1990; in each case, the actual temperature was hotter than the average, but not as hot as the maximum. The predicted levels of water use resulting when the average and maximum temperatures are substituted into the regression equations are shown in Table 8; single-family residential use under year-long maximum temperatures is almost 21% higher than under average temperatures, while irrigation use is 75% higher and governmental uses are 33% higher; by contrast, there is only a 3% impact on combined commercial and multi-family residential uses, and the impact on industrial use is essentially zero. The overall impact on aggregate M&I use is to raise it by 11.6%.

Note that these figures are based on a somewhat extreme comparison -- normal weather versus the hottest weather over the last 46 years. The reason for generating them was to place an *upper bound* on the possible impacts of weather on M&I demand: a typical hot year will involve *lower* temperatures than the maximum temperatures considered here, and the increase in demand will be correspondingly smaller. Some alternative, and lower, figures are presented in the LADWP and MWD-MAIN reports. The LADWP-UWMP report suggests having a band of plus or minus 8% around its projections of M&I demand to allow for variation in weather, but the analysis on which that figure is based is not described. The impact of hotter temperatures on M&I demand is also considered in the MWD-MAIN report, which summarizes the results of a statistical analysis for the entire MWD service area similar to that performed here for LADWP. The MWD-MAIN study compared M&I demand in normal temperature years with demand in years that have temperatures corresponding to the 95% percentile -- i.e. the temperature that can be expected to be exceeded only 1 year in 20, based on some period of record. This is a milder criterion than the maximum temperature on record, and therefore the adjustment of M&I use for higher temperatures is smaller than in our analysis. For Los Angeles County as a whole, the MWD-MAIN study reports that M&I use under above-normal temperatures, as it defines them, is 5% larger than in normal years.

Another factor that could affect the forecasts of aggregate M&I demand is errors in the demographic projections. As already noted, both LADWP-UWMP and MWD-MAIN use demographic forecasts which ultimately derive from the 1980 Census. There are several indications that population in Southern California actually grew faster during the late 1980's than demographers had expected, so that the 1990 population will turn out to higher than anticipated. Some data on this are contained in an document submitted by MWD in July 1992 to the State Water Resources Control Board's Interim Water Rights Hearing. This document -- State Water Contractors Exhibit 3d -- contains some new forecasts of MWD's future service population that were developed for MWD by the Center for the Continuing Study of the California Economy and incorporate preliminary information from the 1990 Census. The forecasts presented in the Exhibit are for the entire MWD service area, and do not break out subaggregates such as LADWP. For the MWD service area as a whole, these new forecasts project a population which is 13% larger in 2000 than previously projected by MWD, and 11.3% larger in 2010 (see Table 9). At this time we have no way of knowing whether the projections for the LADWP service area would show a similar increase.

Given these two sets of factors that might raise demand -- hotter than normal temperatures and a greater population growth than previously anticipated -- it seems prudent to analyze a scenario in which aggregate demand within the LADWP service area is 10% higher than the LADWP-UWMP forecasts. This is intended as a rough approximation to a worst case scenario -- not the maximum that could possibly occur, but an outcome that is intended to be on the high side.

So far we have considered factors that might make demand higher than the LADWP-UWMP estimates. The main factor that could make demand lower is additional conservation beyond that already factored into these forecasts. The two main components of M&I use which could be a source of substantial additional conservation are ultra-low flush (ULF) toilets and outdoor use.

Since 1990, LADWP and Santa Monica have implemented incentive programs to promote the retrofit of ULF toilets. An evaluation of those programs has recently been published by Chesnutt et al. (1992). This report presents the results of a careful and comprehensive assessment, based on a large sample of program participants. It estimates the savings from ULF at about 50 gallons/day/household for typical single- and multi-family households that installed ULF toilets (this estimate is based on the assumption that the household has two toilets and replaces both of them). That figure is in line with the assumptions underlying the MWD-MAIN model -- if anything, it is higher by a few gallons/day/household (with about 3 persons per household, the ULF toilet savings amount to about 17 gpcd). The key issue, however, is the rate at which the adoption of ULF toilets spreads through the LADWP service area. The MWD-MAIN model assumes a fairly modest rate of adoption by 2010. If the actual rate of adoption were higher, the savings could be larger than estimated by MWD-MAIN. With regard to LADWP-UWMP, the indoor conservation savings in that study were focused mainly on the effects of the 1980 Plumbing Code, rather than ULF toilets and the 1990 Code. Therefore, with the advent of ULF toilets, the savings are likely to be somewhat higher than projected in LADWP-UWMP. Depending on the rate of adoption, we believe that they could reduce M&I demand in 2010 by about 5 gpcd below the current forecasts.

It is a striking fact that most of the existing efforts since 1980 have focused on indoor water use -- so far, relatively little effort has been targeted at outdoor use by residential or commercial customers. However, outdoor use is an important component of M&I demand. The data presented in LADWP-UWMP assume that outdoor use in 1990 is just under 34% of total M&I use in the LADWP service area, and is split so that roughly 31% occurs in the commercial and governmental sectors while 69% occurs in the residential sector. However, the projected savings from conservation in outdoor uses account for only about 18% of the total savings from conservation in 2010. There are some grounds for believing that substantial savings in outdoor uses could be achieved if a concerted effort were made. Testimony presented by DWR at the Bay Delta Hearings in 1987 suggested that there could be a savings of up to 25% in existing outdoor uses, and 40% in new uses, with an aggressive program of outdoor conservation. LADWP-UWMP assumes that 70% of existing outdoor use in 1990 is amenable to conservation, that conservation could reduce it by 20%, and that 50% of that reduction will be realized by 2010. Hence, it assumes that conservation reduces 1990 outdoor use by 7% in the year 2010. Two points should be noted. First, it may be possible to achieve a greater diffusion of outdoor conservation by 2010 if appropriate measures are taken. In this regard, the new increasing block rate structure being considered for LADWP provides significantly stronger incentives for reducing outdoor use than the existing price structure, Hence, there is some chance that a reduction of more than 7% in aggregate outdoor use could be achieved by 2010. Second, the LADWP-UWMP analysis implicitly assumes no increase in the absolute amount of outdoor use over the period 1990-2010. While it does allow for some increase in M&I use over this period, to the extent that outdoor uses play an major role in this growth LADWP may be underestimating the growth in M&I use. On the other hand, since it is easier to reduce outdoor use associated with new construction, the opportunities for significant savings from conservation are greater. When all these factors are considered, we believe that it might be possible to reduce aggregate M&I use in 2010 by another 3-5 gpcd through a more aggressive program of outdoor conservation.

TABLE 1: ALTERNATIVE CLASSIFICATIONS OF M&I USE COMPONENTS

<table>
<tr><th>CATEGORIES IN LADWP RECORDS</th><th>CATEGORIES USED BY MWD-MAIN</th><th>CATEGORIES USED IN LADWP-UWMP</th></tr>
<tr><td>SINGLE-FAMILY RESIDENTIAL</td><td>SINGLE-FAMILY RESIDENTIAL</td><td>SINGLE-FAMILY RESIDENTIAL</td></tr>
<tr><td>MULTI-FAMILY RESIDENTIAL</td><td>MULTI-FAMILY RESIDENTIAL</td><td>MULTI-FAMILY RESIDENTIAL</td></tr>
<tr><td>COMMERCIAL</td><td>COMMERCIAL</td><td rowspan="5">COMMERCIAL/INDUSTRIAL/GOVERNMENT</td></tr>
<tr><td>INDUSTRIAL</td><td>INDUSTRIAL</td></tr>
<tr><td>PUBLIC/GOVERNMENTAL</td><td rowspan="5">OTHER</td></tr>
<tr><td>IRRIGATION</td></tr>
<tr><td>OTHER, REVENUE-PRODUCING</td></tr>
<tr><td>UNACCOUNTED</td><td rowspan="2">OTHER</td></tr>
<tr><td>OTHER, NON-REVENUE-PRODUCING</td></tr>
<tr><td>TOTAL DISTRIBUTION</td><td>TOTAL DISTRIBUTION</td><td>TOTAL DISTRIBUTION</td></tr>
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TABLE 2: MWD-MAIN FORECASTS OF M&I USE WITHIN LADWP SERVICE AREA

M&I USE (AFY)	1980	1985	1990	1995	2000	2005	2010
BASE WATER USE							
SF	219,365	249,355	259,517	268,523	275,309	278,519	280,267
MF	159,826	190,863	212,867	231,011	251,284	272,050	295,048
Residential	379,192	440,217	472,385	499,535	526,595	550,570	575,315
Commercial	150,697	161,188	171,227	188,810	203,491	214,688	223,223
Industrial	46,399	42,870	38,639	37,241	36,631	36,429	36,822
Other	43,068	60,303	60,941	64,812	68,487	71,611	74,618
Total	619,357	704,579	743,193	790,397	835,202	873,296	909,979
WATER USE WITH CONSERVATION							
SF	219,365	241,333	234,814	240,602	244,599	245,606	245,436
MF	159,826	185,830	198,541	212,298	227,968	243,962	261,762
Residential	379,192	427,164	433,354	452,900	472,567	489,568	507,198
Commercial	150,697	156,362	165,593	181,964	195,541	205,816	213,581
Industrial	46,399	41,739	37,620	36,259	35,664	35,468	35,850
Other	43,068	60,303	60,941	64,812	68,487	71,611	74,618
Total	619,357	685,568	697,509	735,935	772,259	802,461	831,246
WATER USE WITH BMP							
SF	219,365	241,333	234,814	232,033	233,511	233,224	230,821
MF	159,826	185,830	198,541	204,402	217,605	232,056	246,707
Residential	379,192	427,164	433,354	436,435	451,116	465,282	477,528
Commercial	150,697	156,362	165,593	177,584	188,755	196,818	202,373
Industrial	46,399	41,739	37,620	35,976	35,132	34,719	34,849
Other	43,068	60,303	60,941	64,812	68,487	71,611	74,618
Total	619,357	685,568	697,509	714,806	743,490	768,429	789,368
POPULATION	2,969,163	3,221,013	3,437,264	3,567,252	3,673,026	3,758,129	3,849,167

TABLE 2: MWD-MAIN FORECASTS OF M&I USE WITHIN LADWP SERVICE AREA

	1980	1985	1990	1995	2000	2005	2010
WATER USE FACTORS (GPD)							
BASE WATER USE							
Per SF Residential Unit	384.3	424.0	426.0	429.4	434.0	437.6	440.3
Per MF Residential Unit	227.8	257.3	266.5	270.8	277.0	282.6	287.3
Per commercial employee	92.4	93.7	95.1	99.4	102.1	103.6	104.0
Per industrial employee	118.7	121.4	119.2	118.6	117.8	116.5	114.9
Total M&I Use per capita (gpcd)	186.2	195.3	193.1	197.8	203.0	207.5	211.1
Aggregate Residential Use per capita (gpcd)	114.0	122.0	122.7	125.0	128.0	130.8	133.5
WATER USE WITH CONSERVATION							
Per SF Residential Unit	384.3	410.4	385.4	384.8	385.6	385.9	385.6
Per MF Residential Unit	227.8	250.5	248.6	248.9	251.3	253.5	254.9
Per commercial employee	92.4	90.9	92.0	95.8	98.1	99.3	99.5
Per industrial employee	118.7	118.2	116.0	115.5	114.7	113.4	111.9
Total M&I Use per capita (gpcd)	186.2	190.0	181.2	184.2	187.7	190.6	192.8
Aggregate Residential Use per capita (gpcd)	114.0	118.4	112.6	113.4	114.9	116.3	117.7
WATER USE WITH BMP							
Per SF Residential Unit	384.3	410.4	385.4	371.1	368.1	366.4	362.6
Per MF Residential Unit	227.8	250.5	248.6	239.6	239.9	241.1	240.2
Per commercial employee	92.4	90.9	92.0	93.5	94.7	94.9	94.2
Per industrial employee	118.7	118.2	116.0	114.6	113.0	111.0	108.8
Total M&I Use per capita (gpcd)	186.2	190.0	181.2	178.9	180.7	182.6	183.1
Aggregate Residential Use per capita (gpcd)	114.0	118.4	112.6	109.2	109.7	110.5	110.8
% SF Housing Units	44.9%	44.2%	43.3%	42.3%	41.2%	39.8%	38.3%

TABLE 3: LADWP-UWMP FORECASTS OF M&I USE

		1980	1985	1990	1995	2000	2005	2010
	SF POPULATION ('000)	1608	1670	1730	1730	1730	1730	1730
	MF POPULATION ('000)	1369	1557	1730	1843	1955	2057	2145
1	TOTAL POPULATION ('000)	2977	3227	3460	3573	3685	3787	3875
2	% SF	54.0%	51.8%	50.0%	48.4%	46.9%	45.7%	44.6%
	[GPCD]							
3	SF residential base	135	125	125	125	125	125	125
4	MF residential base	90	103	105	105	105	105	105
5	Overall residential base	114.3	114.4	115.0	114.7	114.4	114.1	113.9
6	CIG base	54.9	54.9	54.9	54.9	54.9	54.9	54.9
7	CIG growth trend	0.0	0.2	1.1	2.1	3.6	5.1	5.8
8	CIG	54.9	55.1	56.0	57.0	58.5	60.0	60.7
9	Unaccounted/other	10.8	10.8	10.8	10.8	10.8	10.8	10.8
10	M&I general growth trend	0.0	0.9	1.5	2.0	2.4	2.9	3.4
11	BASE M&I USE	180.0	181.2	183.3	184.5	186.1	187.8	188.8
12	Residential indoor conservation	0	-1.8	-4.1	-6.2	-7.6	-9.1	-10.6
13	CIG indoor conservation	0	-0.2	-0.4	-0.5	-0.7	-1	-1.2
14	Outdoor conservation	0	-0.4	-0.7	-0.8	-1.1	-1.9	-2.6
15	Reduction in unaccounted	0	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
16	SF residential	135.0	123.6	121.5	119.7	118.4	116.7	115.2
17	MF residential	90.0	101.6	101.5	99.7	98.4	96.7	95.2
18	Overall residential	114.3	113.0	111.5	109.4	107.8	105.9	104.1
19	CIG	54.9	55.0	55.8	56.8	58.1	59.1	59.5
20	Unaccounted	10.8	10.6	10.6	10.6	10.6	10.6	10.6
21	TOTAL M&I USE	180.0	178.6	177.9	176.8	176.5	175.6	174.2
1	TOTAL POPULATION ('000)	2977	3227	3460	3573	3685	3787	3875
	[AFY]							
	SF RESIDENTIAL	243,130	231,140	235,437	231,918	229,387	226,207	223,144
	MF RESIDENTIAL	137,995	177,135	196,685	205,784	215,429	222,887	228,625
22	OVERALL RESIDENTIAL	381,125	408,275	432,121	437,702	444,816	449,094	451,769
23	CIG	183,000	198,809	216,142	227,266	239,782	250,836	258,316
24	UNACCOUNTED	36,010	38,311	41,077	42,419	43,748	44,959	46,004
25	TOTAL M&I USE	600,135	645,396	689,340	707,386	728,346	744,888	756,089
26	TOTAL M&I USE ('000AFY)	600.2	645.7	689.9	707.3	728.4	745.5	756.5

NOTES:

(16) = (3)+(12)+0.608*(14)+0.69*(10)
(17)= (4)+(12)+0.608*(14)+0.69*(10)
(19) = (8)+(13)+ 0.392*(14) + 0.31*(10)
(22) = (1)*(18); (23) = (1)*(19); (24) = (1)*(20)
(25) = (22)+(23)+(24)
(26) TAKEN FROM LADWP-UWMP (1990), EXHIBIT 3.3-2.

TABLE 4: COMPARISONS OF MWD-MAIN & LADWP-UWMP FORECASTS WITH ACTUAL CONSUMPTION IN 1990

	1990 MWD-MAIN FORECAST (AFY)	1990 ACTUAL (AFY)	RATIO: FORECAST/ ACTUAL
SINGLE-FAMILY RESIDENTIAL	234,825	243,449	96.5%
MULTI-FAMILY RESIDENTIAL	198,541	202,126	98.2%
COMMERCIAL	165,593	125,010	132.5%
INDUSTRIAL	37,620	28,246	133.2%
GOVERNMENTAL/UNACCOUNTED	60,941	95,935	63.5%
TOTAL	697,520	694,766	100.4%

	1990 LADWP-UWMP FORECAST (AFY)	1990 ACTUAL (AFY)	RATIO: FORECAST/ ACTUAL
SINGLE-FAMILY RESIDENTIAL	235,437	243,449	96.7%
MULTI-FAMILY RESIDENTIAL	196,685	202,126	97.3%
COMMERCIAL/INDUSTRIAL/GOVERNMENTAL	216,142	198,991	108.6%
UNACCOUNTED	41,077	50,200	81.8%
TOTAL	689,340	694,766	99.2%

TABLE 5: COMPARISON OF MWD-MAIN & LADWP-UWMP FORECASTS FOR 2010

	2010 MWD- MAIN FORECAST (AFY)	2010 LADWP-UWMP FORECAST (AFY)	RATIO: MWD-MAIN/ LADWP-UWMP
SINGLE-FAMILY RESIDENTIAL	230,821	223,144	103.4%
MULTI-FAMILY RESIDENTIAL	246,707	228,625	107.9%
COMMERCIAL	202,373		
INDUSTRIAL	34,849	258,316	
GOVERNMENTAL			
UNACCOUNTED	74,618	46,004	
TOTAL	789,368	756,089	104.4%

TABLE 6: REGRESSION EQUATIONS FOR EFFECTS OF WEATHER ON M&I DEMAND IN LADWP SERVICE AREA

LS // Dependent Variable is RES
Date: 10-07-1992 / Time: 14:17
SMPL range: 1985.08 - 1990.12
Number of observations: 65

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	-54.675577	15.207936	-3.5952004	0.0007
PREC	-0.2256184	0.9463914	-0.2383987	0.8124
PREC(-1)	-2.9819537	0.9623761	-3.0985325	0.0030
TEMP	0.6437425	0.2825623	2.2782318	0.0263
TEMP(-1)	1.4631595	0.2777700	5.2675227	0.0000

R-squared	0.769884	Mean of dependent var	84.12738
Adjusted R-squared	0.754543	S.D. of dependent var	16.48287
S.E. of regression	8.166208	Sum of squared resid	4001.217
Log likelihood	-226.1299	F-statistic	50.18460
Durbin-Watson stat	0.918027	Prob(F-statistic)	0.000000

LS // Dependent Variable is TOT
Date: 10-07-1992 / Time: 14:17
SMPL range: 1985.08 - 1990.12
Number of observations: 65

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	12.856323	29.381856	0.4375599	0.6633
PREC	0.8002782	1.8284359	0.4376846	0.6632
PREC(-1)	-6.5856935	1.8593185	-3.5419932	0.0008
TEMP	0.8716696	0.5459127	1.5967197	0.1156
TEMP(-1)	2.3481393	0.5366538	4.3755196	0.0000

R-squared	0.702255	Mean of dependent var	224.2860
Adjusted R-squared	0.682405	S.D. of dependent var	27.99580
S.E. of regression	15.77718	Sum of squared resid	14935.17
Log likelihood	-268.9363	F-statistic	35.37870
Durbin-Watson stat	1.369963	Prob(F-statistic)	0.000000

LS // Dependent Variable is CA
Date: 10-07-1992 / Time: 14:08
SMPL range: 1985.08 - 1990.12
Number of observations: 65

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	82.970672	12.927097	6.4183529	0.0000
PREC	0.1864332	0.8044546	0.2317510	0.8175
PREC(-1)	-2.8929327	0.8180419	-3.5364112	0.0008
TEMP	-0.1564887	0.2401845	-0.6515353	0.5172
TEMP(-1)	0.6443599	0.2361109	2.7290564	0.0083

R-squared	0.439807	Mean of dependent var	113.5931
Adjusted R-squared	0.402461	S.D. of dependent var	8.979828
S.E. of regression	6.941466	Sum of squared resid	2891.037
Log likelihood	-215.5680	F-statistic	11.77649
Durbin-Watson stat	1.937284	Prob(F-statistic)	0.000000

TABLE 7: ACTUAL, NORMAL AND MAXIMUM TEMPERATURE IN LOS ANGELES

	MONTH	ACTUAL TEMPERATURE	NORMAL TEMPERATURE	MAXIMUM TEMPERATURE
1989	JULY	75.1	71.9	79.2
	AUGUST	72.8	72.6	80.8
	SEPTEMBER	74.5	71.2	81.3
	OCTOBER	69.2	67.0	74.2
	NOVEMBER	66.7	62.3	67.2
	DECEMBER	62.7	57.8	63.7
1990	JANUARY	59.4	56.3	65.9
	FEBRUARY	58.0	57.5	64.6
	MARCH	61.7	58.9	65.6
	APRIL	65.7	61.2	67.9
	MAY	66.9	63.8	72.4
	JUNE	74.3	67.6	78.0

NOTE: Average daily temperatures (Fahrenheit) at LA Civic Center over the month. Normal and average are for the month averaged over the period 1944-1990.

SOURCE: James Ruffner and Frank Blair (eds) WEATHER OF US CITIES, Vol. 1 Gale Research Co, Detroit. 2nd edition (1985); 4th edition (1990)

TABLE 8: EFFECT OF TEMPERATURE ON 1990 M&I USE IN LADWP SERVICE AREA (AFY)

	PREDICTED M&I USE WITH NORMAL TEMPERATURE	PREDICTED M&I USE WITH MAXIMUM TEMPERATURE	RATIO M&I USE MAX TEMP/ NORMAL TEMP
SINGLE FAMILY RESIDENTIAL	223,984	270,593	120.8%
MULTI-FAMILY RESI + COMMERCIAL	322,266	333,045	103.3%
INDUSTRIAL	30,163	30,163	100.0%
GOVERNMENTAL	39,245	52,308	133.3%
IRRIGATION (NON-GOVTL)	1,229	2,150	175.0%
TOTAL	616,887	688,259	111.6%

TABLE 9: ALTERNATIVE POPULATION PROJECTIONS

	LADWP SERVICE AREA (IN THOUSANDS)					MWD SERVICE AREA (IN MILLIONS)			
	1990	1995	2000	2005	2010	1990	1995	2000	2010
(A) LADWP (1990)	3,459.6	3,572.6	3,685.3	3,786.8	3,875.2				
(B) MWD: PMC (1991)	3,437.3	3,567.3	3,673.0	3,758.1	3,849.2	14.8	15.6	15.6	18.2
(C) MWD: CCSECE (1992)						14.9	16.3	17.6	20.3
% DIFFERENCE C/B						0.8%	4.3%	13.0%	11.3%
% DIFFERENCE A/B	0.6%	0.2%	0.3%	0.8%	0.7%				