APPENDIX B1

REPRESENTATION OF URBAN WATER DEMANDS AND LOCAL SUPPLIES

Marion W. Jenkins

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INTRODUCTION

This appendix explains how state-wide urban (M&I) water demands and local urban water supplies in California are represented in the CALVIN model. State-wide M&I demands are separated into three groups depending on the degree to which their water supplies are included in CALVIN. Demand areas that are served exclusively by supplies outside the inter-tied water system model of CALVIN (see the schematic model) are excluded from analysis. Demand areas supplied by water sources optimized in the CALVIN model are included as economic value functions or as fixed required diversions, depending on conditions described further in this appendix. The aggregation of local M&I demands into larger areas is also explained in this appendix. Demands represented in CALVIN are projected at 2020 levels according to the California Department of Water Resources (DWR) data on per capita urban water use by county and population by detailed analysis unit (DAU) assembled for Bulletin 160-98. According to these data, the total 2020 projected population in California is 47,507,399. The total annual demand is then divided into sectors (residential, industrial, and other) and monthly levels according to regional and agency information about sector and monthly use patterns in Bulletin 166-4 (DWR 1994). The last section of this appendix describes the different ways that local urban water sources and projected supply availability in 2020 are represented in CALVIN.

URBAN WATER DEMANDS INCLUDED IN CALVIN

Statewide urban water demands in California at the DAU level are separated into three groups according to their water supply sources and their size. The three groups are explained next. Details of the DAU assignments are provided in the file “Daulist.xls” (Software and Data Appendices).

Demands Excluded from CALVIN Analysis

These are demands fully supplied by water sources outside the CALVIN model. For example, all M&I water use in the North Coast and North Lahontan hydrologic regions and most in the Central Coast hydrologic region of California are excluded because water supplies for these areas are completely isolated from supplies modeled in CALVIN. DAUs with isolated water systems in other hydrologic regions are also excluded. Excluded DAUs were identified from M&I water purveyor information in Bulletin 166-4 (DWR 1994), from examination of DAU boundary maps, and examination of CVPM groundwater region boundaries. The list of excluded DAUs, representing 7.6% of the projected 2020 population, is provided in Table B1-1.

Demands Included in CALVIN as Fixed Diversions (Type "TS")

Small demands that may be important to the mass balance accounting of water sources modeled in CALVIN are generally included as fixed diversions. These consist mostly of exclusive M&I groundwater users in the Central Valley and several small surface water diverters at various other locations in CALVIN. A complete list is provided in Table B1-2. About 12% of the statewide projected population in 2020 is represented by these fixed diversion demands. In all cases, these fixed urban diversions are explicitly identified on the schematic and in the input and output data. M&I water use for approximately 12% of the 2020 projected California population is represented as fixed diversions in CALVIN. These demands represented as a fixed time-series of deliveries are designated as "TS" demands.

Fixed diversions from groundwater for Central Valley M&I users in Table B1-2 are detailed in files "Urbnode.xls" and "GWpump.xls" (Software and Data Appendices). Deep percolation of applied water for these urban regions is calibrated to match the CVGSM "No Action

Table B1-1. Detailed Analysis Units Excluded from CALVIN Analysis of Urban Demands

Hydrologic Regions	Excluded DAUs	2020 Population	Reason
North Coast	All	835,320	Isolated water supply
San Francisco	38, 39a, 39b, 42	514,900	Isolated water supply
Central Coast	48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 63, 64, 65, 66, 69, 70, 72, 73, 76	1,017,810	isolated water supply
South Coast	None	0	
Sacramento River	130, 132, 134, 136, 137, 139, 145, 147, 154, 156, 160, 174, 175	411,885	isolated water supply or too small population
San Joaquin	176, 194, 195, 196, 198, 217, SJ05, SJ08	427,585	isolated water supply or too small population
Tulare Lake	234, 247, all of TL01, all of TL04	146,165	isolated water supply or too small population
North Lahontan	262, 263, 264, 265, 266, 268, 270	124,460	isolated water supply
South Lahontan	SL01, SL02	43,350	isolated water supply
Colorado River	all in CR02, CR03 and CR05	73,050	isolated water supply
	Total Excluded	3,594,525	

Demands Included in CALVIN as Economic Values

Economically modeled urban water demand areas in CALVIN are generally large M&I water users with water supply systems integrated into the inter-tied California state-wide water distribution system and dependent on imported water from outside their service area boundaries. Two approaches presently are used in CALVIN to approximate the economic value of these urban water demands. The first approach combines all urban water use sectors and develops a single economic value function (type "CF", a single combined demand function of all urban demands for a local area). The second approach separates industrial water use from residential and other water uses and develops two separate value functions (type "SF", a split economic value function with separate industrial and residential/other value functions). Appendix B2 describes in detail the methods, assumptions, and data used to develop these economic value functions.

All economically modeled urban demand areas located outside the San Francisco Bay and South Coast Hydrologic Regions are represented by a combined ("CF") water value function because data on industrial water values are unavailable for these areas at present. Industrial production data to assess the value of industrial water use is only available for the twelve San Francisco Bay Area and South Coast Counties at this time (see Appendix B2 for more details). In a few cases, such as Antelope Valley, Mojave River Valley, and Coachella Valley in the eastern parts of Southern California, industrial water use as a percentage of total urban water use is extremely small (1 to 2 %) and can be neglected (DWR 1993a).

AGGREGATION OF DEMAND AREAS

Fixed diversion demands, the second category above, are aggregated by supply source and by diversion point. For example, sparsely populated areas and small isolated communities who depend exclusively on groundwater for their M&I supplies are aggregated for each Central Valley groundwater basin. These DAUs are assigned to a groundwater basin based on location over that basin (see details in files "Daulist.xls", "Daubase.xls", and "Urbnode.xls" in Software and Data Appendices). Sub-division of DAUs is not done unless specifically noted. In several locations, for example at Shasta Lake, the water requirements of small isolated M&I surface water users who divert from this source are aggregated together and represented as a fixed urban diversion. Presently, there are 21 fixed diversion urban demand areas in the CALVIN model schematic of which 19 withdraw from Central Valley groundwater basins and three from surface water sources. Table B1-2 lists the fixed diversion demand areas, their aggregated DAUs, and their diversion points.

For urban demands which are economically represented in CALVIN (the third category above), water users are aggregated into a demand area based on adjacency, a shared institutional framework, and an integrated physical system for managing water supply. This means that urban demand areas in CALVIN generally respect the boundaries of the major urban water supply agencies in the San Francisco Bay Area and in Southern California requiring several DAUs to be split in these areas. Small water agencies that are expected to experience high growth in water demand by 2020 are represented as separate economic demands rather than as fixed diversions. Table B1-3 lists CALVIN's economically represented urban demand areas which account for about 80% of the 2020 projected California population.

Table B1-2. Fixed Diversion Urban Demand Areas in CALVIN

CALVIN Node Name	DAUs	2020 Pop.[a]	CALVIN Diversion Point	2020 Demand KAF/year	Portion Supplied	Diversion KAF/year
Redding	141, 143	231,495	1) SR-4 (Lake Shasta) 2) GW-1 (CVPM Region 1 Groundwater Basin)	79.4	64% 36%	50.8 28.6
Ventura Co	81	1,022,850	SR-29 (Castaic Lake)	218.8	SWP import only[f]	15.8
El Centro et al	all of CR06[e]	214,250	C312 (on the All Amercian Canal)	51.8	100%	51.8
CVPM 2 Urban	142, 144	190,110	GW-2 (CVPM Region 2 Groundwater Basin)	63.8	100%	63.8
CVPM 3 Urban	163	42,275	GW-3 (CVPM Region 3 Groundwater Basin)	15.7	100%	15.7
CVPM 4 Urban	164, 165, 167	13,590	GW-4 (CVPM Region 4 Groundwater Basin)	5.24	100%	5.24
CVPM 5 Urban	159, 166, 168, 170-1	358,800[c]	GW-5 (CVPM Region 5 Groundwater Basin)	112.1	166, 170- 1, 17% of 159+168	59.34[d]
CVPM 6 Urban	162, 191, 40, 41	894,299[c]	GW-6 (CVPM Region 6 Groundwater Basin)	200.9	162, 9% of 191+40+41	65.4[d]
CVPM 8 Urban	180, 181, 184	92,445	GW-8 (CVPM Region 8 Groundwater Basin)[b]	26.4	100%	26.4
CVPM 9 Urban	185	391,700	GW-9 (CVPM Region 9 Groundwater Basin)	77.1	100%	77.1
CVPM 10 Urban	216	150,580	GW-10 (CVPM Region 10 Groundwater Basin)	41.9	100%	41.9
CVPM 11 Urban	205, 206, 207	653,470	GW-11 (CVPM Region 11 Groundwater Basin)[b]	231.7	100%	231.7
CVPM 12 Urban	208, 209	297,770	GW-12 (CVPM Region 12 Groundwater Basin)	109.6	100%	109.6
CVPM 13 Urban	210-215	422,150	GW-13 (CVPM Region 13 Groundwater Basin)	160.8	100%	160.8
CVPM 14 Urban	244, 245	69,375	GW-14 (CVPM Region 14 Groundwater Basin)	17.4	100%	17.4
CVPM 15 Urban	235, 241, 246, 237-8	216,200	GW-15 (CVPM Region 15 Groundwater Basin)	63.3	100%	63.3
CVPM 17 Urban	236, 239, 240	294,210	GW-17 (CVPM Region 17 Groundwater Basin)	85.0	100%	85.0
CVPM 18 Urban	242, 243	534,140	GW-18 (CVPM Region 18 Groundwater Basin)	147.1	100%	147.1
CVPM 19 Urban	255, 259, 260	41,100	GW-19 (CVPM Region 19 Groundwater Basin)	23.4	100%	23.4
CVPM 20 Urban	256, 257	156,675	GW-20 (CVPM Region 20 Groundwater Basin)	53.9	100%	53.9
CVPM 21 Urban	258, 261	84,150	GW-21 (CVPM Region 21 Groundwater Basin)[b]	25.8	100%	25.8
Total		6,371,634[c]		1811.14		1418.9

[a] *DWR DAU 2020 population data (DWR 1998b)*
[b] *There is additional groundwater extracted for additional urban demand in this CVPM region represented by a separately modeled economic demand area (see Sacramento, Stockton, and Bakersfield in Table B1-3).*
[c] *A portion of this population's water demand is supplied by surface water from outside the groundwater region and represented by another urban demand area of CALVIN (see "Yuba City et al" and "Napa-Solano Co Urban" in Table B1-3).*
[d] *Actual diversion amount reflects portion of 2020 demand supplied by groundwater.*
[e] *CR06 is Colorado River Hydrologic Region Planning Sub-Area 6 "Imperial Valley"*
[f] *Set equal to deliveries in DWRSIM run 514 where diversion in mean annual DWRSIM run 514 delivery.*

Table B1-3. Economically Represented Urban Demand Areas in CALVIN

#	CALVIN Node Name	DAUs Included[b]	2020 Population	Demand KAF/year	CALVIN Maximum Delivery	Description of Major Cities, Agencies, or Associations
20	Yuba City et al	159, 168	210,450	63.83	53.0[a]	Oroville, Yuba City
30	Sacramento Area	172, 173, 158, 161, 186	2,181,605	678.51	678.51	Sacramento Water Forum, Isleton, Rio Vista, PCWA, EID, W. Sacramento, N. Auburn
50	Napa-Solano	191, 40, 41	711,324	148.8	124.3[a]	Cities of Napa and Solano Counties
60	Contra Costa WD	192, 70% of 46	565,352	134.8	134.8	Contra Costa Water District
70	EBMUD	70% of 47, 30% of 46	1,326,460	297.3	297.3	East Bay Municipal Utility District
80	SFPUC	43	1,501,900	238.01	238.01	San Francisco PUC City and County and San Mateo County service areas not in node 90
90	SCV	44, 45, 62, 30% of 47	2,971,513	657.7	657.7	Santa Clara Valley, Alameda County and Alameda Zone 7 Water Districts
110	Santa Barbara-San Luis Obispo	67, 68, 71, 74, 75	713,675	139.2	139.2	Central Coast Water Authority
130	Castaic Lake	83	688,500	176.58	126.58[a]	Castaic Lake Water Agency
140	SBV	44% of 100	878,944	282.52	282.52	San Bernadino Valley Water District
150	Central MWD	87, 89, 90, 92, 96, 114, 56% of 100	15,645,756	3730.70[c]	3730.70	Mainly Los Angeles and Orange County portions of Metropolitan Water District of Southern California (MWD)
170	Eastern & Western MWD	98, 104, 110	2,251,030	740.04[c]	740.04	Mainly Riverside County portion of MWD
190	Antelope Valley Area	SL03, SL04	1,079,650	283.3	277.3[a]	AVEKWA, Palmdale, Littlerock Creek
200	Mojave River	SL05, CR01	1,075,775	354.9	354.9	Mojave Water Agency and Hi Desert Water Agency
210	Coachella Valley	CR04(348, 349)	628,820	600.73	600.73	Dessert Water Agecny, Coachella Valley Water Agency
230	San Diego MWD	120	3,839,800	988.12[c]	988.12	all of San Diego County
240	Stockton	182	421,575	94.90	94.90	City of Stockton
250	Fresno	233	1,142,125	383.74	383.74	Cities of Fresno and Clovis
260	Bakersfield	254	612,100	260.50	260.50	City of Bakersfield
		Total Included	38,446,354	10,250.2	10,170.0	

[a] *CALVIN demand reduced from 2020 demand by the amount of local water supplies not modeled in CALVIN (see Table B1-5) and/or by the amount of fixed groundwater diversions modeled at another urban node (see CVPM 5 Urban and CVPM 6 Urban in Table B1-2).*
[b] *100% of DAU population included in demand area unless otherwise indicated*
[c] *Based on the sum of the maximum monthly demands from a hydrologic sequence of varying 2020 monthly demands provided by MWD (see file "Adjusted MWD Demands.xls" in Software and Data Appendices).*

2020 DEMAND PROJECTIONS

CALVIN urban water demands, whether modeled economically or as fixed diversions, are based on 2020 projections and average conditions (i.e., climatologically normal years) except for those of the Metropolitan Water District (MWD) of Southern California. MWD's demands are based on varying hydrologic conditions. The data and method used to derive 2020 urban demands for the three MWD areas are described in more detail below. For all other areas besides MWD, 2020 projected average demands are computed from California Department of Water Resources 2020 DAU population projections and 1995 baseline per capita water consumption levels by county from Bulletin 160-98 data (DWR 1998a, DWR 1998b). These projected data put the 2020 state-wide population at 47.5 million and suggest a state-wide average M&I (applied) water use level in 1995 of 224 gallons per capita per day (Table 4-8, Bulletin 160-98). By using the 1995 baseline per capita consumption to compute 2020 maximum target demands (deliveries), no additional conservation beyond that in place in DWR's 1995 normalized baseline calculations is assumed in CALVIN (DWR 1998a, 1998b). This is the case for all urban demands in CALVIN except those of MWD. Under other assumptions, another set of population and per capita use data could easily be input into the EXCEL spreadsheet-based software developed to pre-process the inputs for each urban demand area in CALVIN (see file "URBAN3 v2.xls" in Software and Data Appendices).

To compute the per capita water use value for each DAU, a simple average was taken of county values in the DWR database that overlap with the DAU boundary. The per capita use value for each CALVIN urban demand area is then determined by computing a population-weighted average value of the DAUs composing the area.

For the three MWD areas modeled in CALVIN (Central MWD, Eastern & Western MWD, and San Diego), the 2020 projected water demands were provided directly by MWD as a time series varying with hydrologic conditions from January 1922 to December 1991. The current version of CALVIN is limited to a single value function for each month irrespective of year type. To capture MWD's variability in demands, given the present limits of CALVIN, several adjustments were developed. First, the time series was extended at both ends to cover the 72 year hydrologic sequence used in this analysis (October 1921 to September 1993). The most similar years to the missing years, based on inflow to the City of San Diego, were used to fill in the sequence (see file "Adjusted MWD Demands.xls" in Software and Data Appendices). The 2020 maximum monthly demands were then extracted from the MWD time series data and summed to get a 2020 maximum annual demand. This latter value is taken as the 2020 maximum target demand used to construct the economic value functions of water. Additionally, a monthly time series of the difference between the maximum monthly demand and the actual MWD projected monthly demand over the hydrologic sequence was computed and is included in CALVIN as an inflow at the water treatment plant node directly upstream of each MWD demand area. Thus, each month this inflow serves to adjust the maximum target demand value function downward by the appropriate amount so that the month's maximum target demand matches the actual projected MWD demand for that hydrologic period.

BREAKDOWN OF DEMAND BY SECTOR

Once overall annual demand for a CALVIN urban area has been estimated, the demand by sector is calculated as a percentage of the total. State-wide information up to 1991 on the breakdown of urban demand into residential, commercial, government/public, industrial, and unaccounted use in each of the 10 hydrologic regions of California is available from DWR (1993a, Table 6-9). This information reflects the most recent statewide data and is used to split demand into three sectors (residential, industrial, and other). Each sector is treated differently for valuation purposes (see Appendix B2).

MONTHLY DEMAND PATTERN

For each CALVIN urban area, whether a fixed withdrawal or an economically represented demand, annual demand must also be dissagreggated into monthly demands. An overall monthly use pattern for each CALVIN urban demand area is derived from 1980-1990 statewide agency monthly M&I production data published in Bulletin 166-4 (DWR 1994). Production data for the major water agencies listed in this Bulletin located within each CALVIN demand area according to referenced DAU are averaged to determine a production-weighted monthly use pattern. Details of the agencies, their production data, and the calculations can be found in the file "Monthp90.xls" (Software and Data Appendices). Figures B1-1 and B1-2 respectively, display computed monthly use patterns for coastal and interior urban demand areas in CALVIN.

Figure B1-1. Urban Coastal Monthly Use Patterns
1=Napa/Solano 2=SCV 3=EBMUD 4=CCWD 5=SFPUC 6=Santa Barbara
7=Ventura 8=San Diego

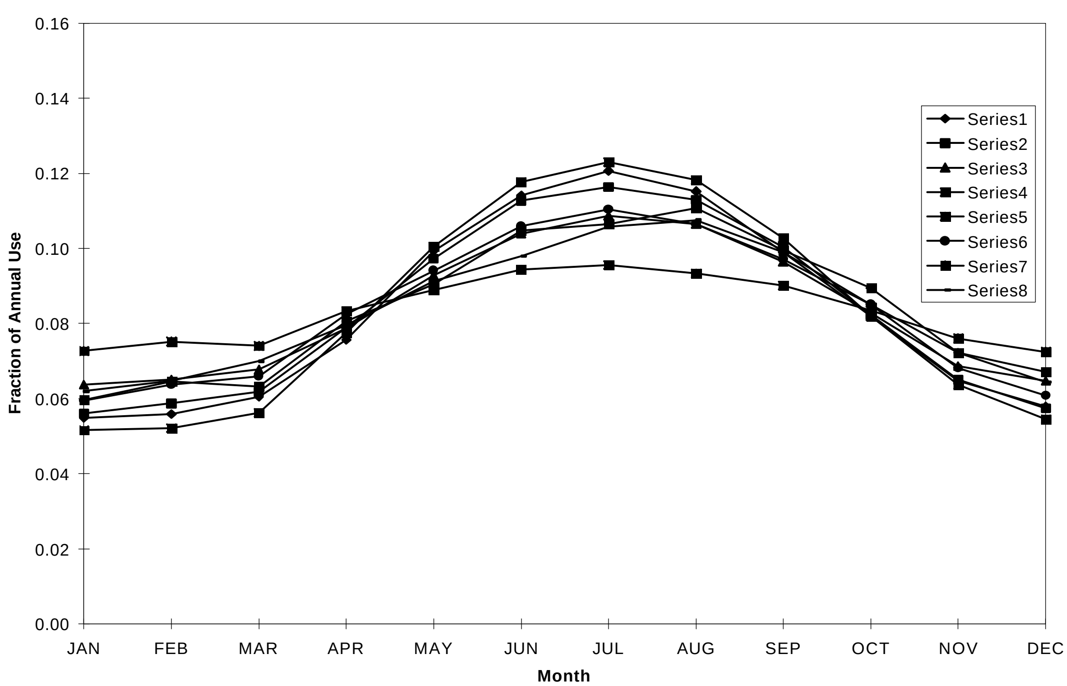
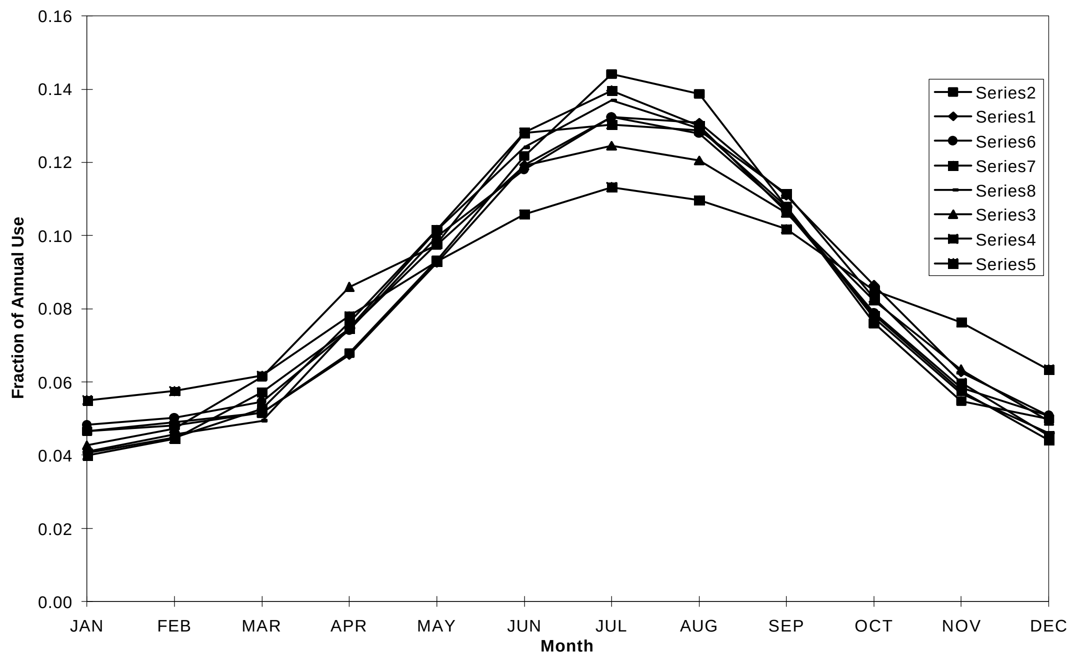
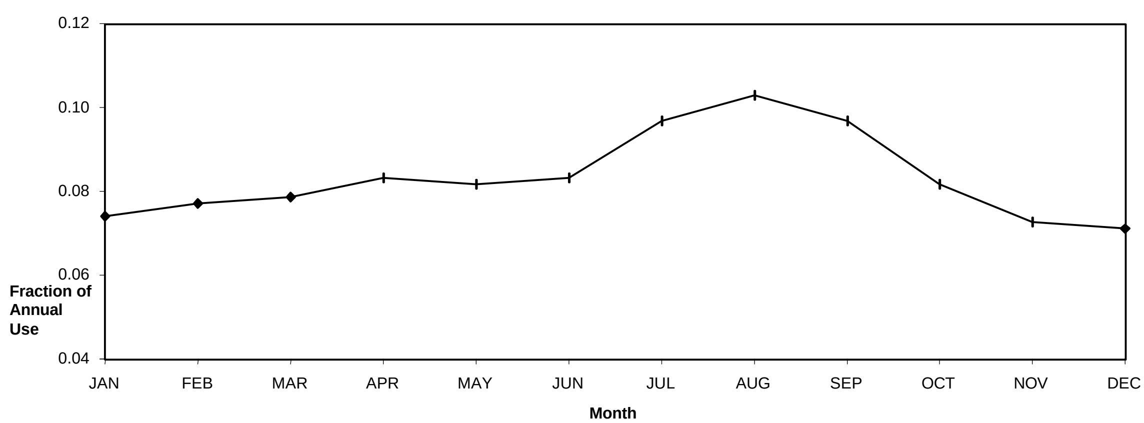


Figure B1-2. Urban Interior Monthly Use Patterns
1=Sacramento 2=Redding 3=Mojave 4=Antelope 5=Coachella 6=Stockton
7= Bakersfield 8= Fresno



In urban demand areas with separate industrial value functions (see above), an industrial statewide average monthly use pattern (see Figure B1-3), taken from the CUWA study (1991; Figure 4-5 on p.4-27), is applied to the industrial portion of demand. The overall agency-based monthly production pattern is applied only to the residential and other portion of demand or to total demand for demand areas represented by either a fixed withdrawal or a combined value function (all sectors together).

Figure B1-3. State-wide Average Industrial Monthly Use Pattern



PRICE OF WATER

Where urban demands are economically represented, the price of water is an important parameter in deriving the elasticity-based demand function, used to value urban water use. Analysis in CALVIN is done in present value dollars (1995). Thus, prices for urban water are based on the 1995 California survey of residential water prices (Black and Vetch 1995). Again, to determine the average retail price for a unit of water in 1995, a population-weighted average price of agencies listed in the Black and Vetch survey was computed for each economically represented CALVIN urban demand area. Details of the agencies, prices, and calculations are provided in worksheet “Water Prices 1995” in the file “URBAN3 v2.xls” (Software and Data Appendices).

URBAN APPLIED WATER RETURN FLOWS AND RECLAMATION

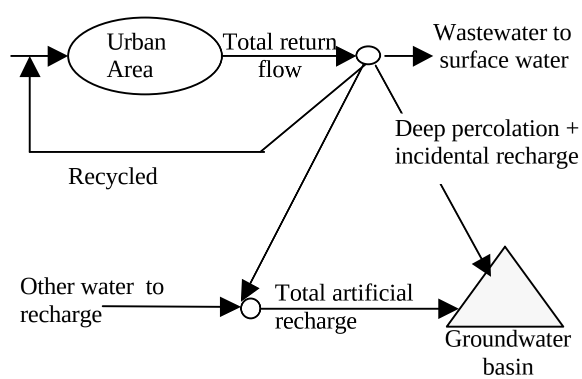
To estimate return flows from urban applied water statewide, a simple approach was taken. The generalized depletion analysis of water applied in the urban sector from Figures 4-1 and 4-2 in the Bulletin 160-98 Public Review Draft (DWR 1998c) is used. According to these figures, 20% of urban applied water deep percolates to the groundwater underlying an urban area, 40% is discharged wastewater, 30% is lost to consumptive use, and 10% is irrecoverable losses from conveyance facilities within the urban area due to evaporation, evapotranspiration, or deep percolation to salt sinks. These percentages are used to estimate the following return flow portions of urban deliveries:

1. deep percolation to groundwater recharge (20%)
2. wastewater discharges (total of 40%) routed to a large number of possible destinations

The final destination in CALVIN of these two return flow components depends on the representation of local groundwater, the type of urban node, and the specific water operations and management activities (recycling, artificial recharge, and disposal of treated wastewater) that now occur or are planned to occur in that node’s area. Further details and cases are elaborated next with application to specific CALVIN urban areas summarized in Table B1-4. Discussion of operating costs for urban return flow water is provided in Appendix G.

Return flows from urban areas can follow a number of paths, illustrated in Figure B1-4 and discussed below.

Figure B1-4. Schematic of Possible Return flows from Urban Regions



Urban Groundwater Return Flows in CALVIN

There are three different return flow pathways by which urban applied water can contribute to groundwater storage. These are direct deep percolation of applied landscape water, incidental recharge of discharged wastewater flows via streambeds, evaporation ponds, or land treatment, and artificial recharge through active management of wastewater treatment plant effluent using percolation ponds, injection wells, or controlled release flows into streams. Treatment and representation in CALVIN of these possible pathways is discussed next.

Deep Percolation of Landscape Irrigation

There are four different ways that deep percolation of urban applied water is treated in CALVIN. The different ways depend on how the groundwater basin and urban demand are represented.

The first case concerns fixed urban groundwater pumping areas in the Central Valley (i.e., CVPM Urban areas shown in Table B1-2). According to the USBR's application of CVGSM in the CVPIA EIS (1997), there are no surface water returns from urban applied water in these areas. All of indoor water use is assumed to end up deep percolating to groundwater in addition to some outdoor landscape use. The gain in CALVIN on the exiting link from these fixed urban groundwater pumping demands in the Central Valley is set to the average fraction of annual urban applied water (both landscape and indoor) that returns to groundwater in each CVPM region in the CVGSM no action alternative model (USBR 1997). In most such cases, deep percolation is approximately 50% of applied water.

The second case concerns urban demands (both fixed and economically represented) that overlay groundwater basins that are not modeled in CALVIN. In these cases, there is no groundwater return flow component and deep percolation is treated as an irrecoverable loss. Gain on the exiting link from these demand areas is set to 0.40 in CALVIN as return flows consist only of the wastewater discharges (see Yuba, Napa-Solano, SB-SLO, Ventura, CLWA, SBV, the three MWD areas, and El Centro et al.).

The third case concerns economically-represented urban demands that overlay CALVIN groundwater basins in the Central Valley. Here, deep percolation of urban applied water is explicitly represented as a fixed lower bound time series equal to 20% of the monthly maximum target demand on the link from the wastewater treatment plant node to the groundwater basin (see Sacramento, Stockton, Fresno, and Bakersfield). The gain on the link exiting these urban demand nodes is set to 0.6 to account for both deep percolation (0.2) and wastewater dishcarge (0.4) return flow components.

The fourth case concerns economically-represented urban demands that overlay CALVIN groundwater basins outside the Central Valley. Here, deep percolation return flow to groundwater is not represented because this component of groundwater recharge appears to be included in the estimates of “natural” recharge used to develop the inflow time series for these non-Central Valley CALVIN basins. They include SCV, Antelope Valley, Mojave River, and Coachella Valley urban areas and basins in CALVIN. Natural recharge estimates for these basins have been taken from local agency planning reports and are based mostly on historic water balance analyses that lump recharge sources together.

Incidental Recharge Component

Urban demand areas that discharge wastewater into streams or evaporation ponds by which incidental (i.e., cost-free and passively managed) infiltration to groundwater occurs have an additional fixed component added to the cost-free deep percolation component on the link exiting a wastewater treatment plant node to a groundwater basin. This additional component reflects additional recharge to groundwater from infiltration of treated wastewater discharges. Currently, the amount assumed in CALVIN, where this occurs, varies from ¼ to ½ of the 40% return flow component of treated wastewater discharges.

Artificial Recharge Component

Urban demand areas that actively recharge wastewater into the groundwater usually have a separate explicit link in CALVIN for this groundwater return flow component, going from the wastewater treatment plant node to a junction node for artificial groundwater recharge. A cost and capacity on this link reflect additional treatment costs and limits on the amount of wastewater used for active artificial recharge. These flows come from the 40% component of treated wastewater discharge return flow. Additionally, total artificial recharge capacity for all sources of water is set downstream of the recharge junction node to reflect the combined installed capacity of percolation ponds (infiltration rate/day x area x days/month) and of injection wells (gpm).

Demand areas in CALVIN with artificial wastewater recharge include the SCV, Mojave River, and Coachella Valley urban areas.

Urban Return Flows to Surface Water in CALVIN

Apart from the portions of wastewater return flow (40%) that end up recharging groundwater via incidental or artificial recharge (see above), and that are recycled to serve demand (see next section), wastewater discharges return to the surface system. In some cases these surface water return flows contribute to usable stream flow and in others they are lost going to non-usable salt sinks. The former case tends to occur in interior regions of California with drainage such as the Sacramento and San Joaquin Valleys, and in some parts of the South Coast region. An exception is the fixed withdrawal CVPM urban areas where wastewater discharges are dispersed and distant and therefore do not contribute to stream flows in CALVIN. In interior regions without drainage where discharges are made to salt water bodies or evaporate in ponds, such as in the Tulare Lake, South Lahontan, and Colorado River regions, the return flow is lost to a sink. This also occurs in coastal regions where discharges are made to the ocean or bay. Wastewater return flows to stream flow are explicitly represented in CALVIN by a direct link from the wastewater treatment plant node to the most appropriate downstream surface system node. Lost wastewater return flows are represented in CALVIN by a direct link from the treatment plant to a sink node.

Urban Return Flow to Recycling in CALVIN

The final portion of treated wastewater return flow that must be accounted for in CALVIN is that going to recycling and reuse in the urban sector. This component of return flow is represented on a direct link from the wastewater treatment plant node to the water treatment plant node of the urban area concerned. A cost and constraint is associated with this recycled flow. Table B1-4 shows those demands where recylcing is represented in CALVIN and Table B1-5 shows the 2020 recycling capacities on these links in CALVIN.

Table B1-4. Representation of Urban Return Flow Components in CALVIN

CALVIN Urban Demand Area(s)	Deep Percol.	Incid. GW Recharge[a]	Artific.GW Recharge[a]	WW to Stream	WW to Sink	WW to Recycle	Return Flow Gain
Fixed Urban GW pumping in the Central Valley	Yes	Yes (10%)	None	No	Yes	No	0.3[b]
Redding	Yes	None	None	Yes	No	No	0.6
Yuba et al	No	None	None	Yes	No	No	0.4
El Centro et al	No (GW not modeled)	No (GW not modeled)	None	No	Yes	No	0.4
Greater Sacramento	Yes	None	None	Yes	No	Yes	0.6
Napa-Solano	No (GW not modeled)	No (GW not modeled)	None	No	Yes	No	0.4 (add dp for CVP6 area)
CCWD & EBMUD	No (GW not modeled)	No (GW not modeled)	No (GW not modeled)	No	Yes	Yes	0.4
SFPUC	No (GW not modeled)	No (GW not modeled)	No (GW not modeled)	No	Yes	Yes	0.4
SCV	Implicit in inflow to GW	None	Yes	No	Yes	Yes	0.4
Stockton and Fresno	Yes	No	None	Yes	No	No	0.6
Bakersfield	Yes	No	None	No	Yes	No	0.6
Ventura Co & SB-SLO	No (GW not modeled)	No (GW not modeled)	No (GW not modeled)	No	Yes	No	0.4
Castaic Lake WA	No (GW not modeled)	None	None	No	Yes	Included in local supply	0.4
Antelope Valley	Implicit in inflow to GW	Yes	None	No	Yes	No	0.4
Mojave River	Implicit in inflow to GW	Yes	Yes	No	Yes	Yes	0.4
Coachella Valley	Implicit in inflow to GW	Yes	Yes	No	Yes	Yes	0.4
SBV	No (Implicit in local supply)	No (Implicit in local supply)	No (Implicit in local supply)	No	Yes	Yes	0.4
Central MWD	No (GW not modeled)[c]	No (GW not modeled)[c]	No (GW not modeled)[c]	No	Yes	Included in local supply	0.4 <should reduce>[d]
E&W MWD & San Diego MWD	No (GW not modeled)	No (GW not modeled)	No (GW not modeled)	No	Yes	Included in local supply	0.4 <should reduce>[d]

Notes:

[a] *From the wastewater discharge component of return flow*

[b] *Correction to 0.40 for incidental recharge of wastewater and for net withdrawal = (0.4-0.1)/0.7*

[c] *The only groundwater modeled in MWD, "GW-MWD", represents proposed conjunctive use space available in existing groundwater basins within the MWD service area for storage of wet weather excess flows from imported sources.*

[c] *Reduced from 0.4 by the amount of recycling and reclamation for groundwater recharge included in 2020 projected local supplies.*

Table B1-5. Urban Recylcing Links and Capacities in CALVIN

CALVIN Urban Node	Recycling Link	2020 Planned Capacity (MGD or KAF/yr)	Unplanned Add'l Capacity (MGD)	Source for Estimate[a]
Redding, Yuba et al, CVPM Urban areas, El Centro et al.	None	0	0	DWR (1998a)
Sacramento	T13 to T4	6 MGD	0	Montgomery Watson (1998)
Stockton	T27 to T26	0	0	DWR (1998a)
Fresno	T25 to T24	0	0	DWR (1998a)
Bakersfield	T29 to T28	0	0	DWR (1998a)
CCWD	T18 to T16	20.4 KAF	0	DWR (1998a)
EBMUD	T35 to T17	22.7 MGD	0	EBMUD (1991) and web site (1998)
Napa-Solano	T15 to T14	0	0	DWR (1998a)
SFPUC	T21 to T20	0	0	SFPUC web site (1998)
SCV	T19 to T7	16 KAF	0	SCVWD (1997) and ACWD (1995)
Antelope Valley	T33 to T6	0	0	USGS (1995)
Mojave River	T32 To T3	7 KAF	0	DWR (1993b, 1998a)
Coachella Valley	T11 to T31	15 KAF	0	Desert Water Agency web site (1999) and DWR (1998a)
Central MWD	T10 to T5	236 KAF[b] included in pre-operated local supply inflow	0	see file "Adjusted MWD Demands.xls" in Software and Data Appendices
Eastern & Western MWD	T12 to T34	57.2 KAF[b] included in pre-operated local supply inflow	0	"
San Diego MWD	T8 to T30	35.2 KAF[b] included in pre-operated local supply inflow	0	"
CLWA	None	Removed from demand	0	McClean (1999)
SBV	T9 to T2	12 KAF	0	"

Notes:
[a] *See details in files "Reg 1-4 Urban documentation.doc" and "Reg 5 Urban documentation.doc" in Software and Data Appendices*
[a] *Not actual capacity, represents annual average production from projected 2020 capacity over varying hydrologic sequence from MWD projections.*

LOCAL SUPPLY SOURCES IN CALVIN

Local water supplies of urban demand areas in CALVIN (i.e., local surface water or groundwater that is not managed as part of the inter-tied state-wide water distribution system) are handled in one of the several ways discussed next.

Local Supplies Deducted from Target Demand

In these cases, the annual average water production of local supplies that are not modeled in CALVIN is estimated in 2020 and deducted from the 2020 maximum target demand prior to developing the fixed diversion requirement or the economic value functions included in the analysis. This is usually the case for local supplies that provide a rather small amount of supply. A list of urban demand areas with excluded local supplies is provided in Table B1-6.

Table B1-6. Fixed Urban Demands Reduced by Local Supplies

CAVLIN Urban Area	2020 Supplies Removed	Demand Reduction KAF/year	Determination/ Source
Antelope Valley	Local surface water for Palmdale	6	See file "Region 5 Urban Documentation.doc" in Software and Data Appendices
Napa-Solano County	1) Local surface water collected in Lake Milliken and Hennessey for Napa area 2) Local groundwater production, included in CVPM region 6 fixed urban groundwater pumping	11.05 13.4	DWR Bulletin 166-4, estimated 9% of demand supplied by groundwater and 18.8% by local surface water in 1990 (see file "Monthp90.xls" and "Region 1-4 Urban Documentation.doc" in Software and Data Appendices
Castaic Lake WA	Local ground and reclaimed water production of member agencies	50	Personal communication with Mr. McClean (see file "Region 5 Urban Documentation.doc" in Software and Data Appendices)
Ventura Co	All local surface, ground, and reclaimed water production	203	Difference between DAU-based 2020 demand and annual average delivery from DWRSIM run 514, see file "Ventura Co.xls" in Software and Data Apendices
Yuba City et al	Local groundwater production, included in CVPM region 5 fixed urban groundwater pumping	10.8	DWR Bulletin 166-4, estimated 16.5% of demand supplied by groundwater in 1990, assumed same % in 2020 (see file "Monthp90.xls" in Software and Data Appendices)
Total		294.3	

Local Supplies Represented Explicitly as Local Inflow Time Series

In these cases, local supplies are explicitly labeled and included in the model as a time-series of pre-processed inflow to the appropriate urban demand area. See for example Santa Barbara-San Luis Obispo or San Bernadino Valley Urban demand areas on the CALVIN schematic. A list of explicitly represented local supply inflows is provided in Table B1-7. Metadata are provided in the database with each inflow item and details of the derivation and data sources are provided in files "Region 1-4 Urban Documentation.doc" and "Region 5 Urban Documentation.doc" in Software and Data Appendices. In this case, the sequence of monthly production of these local sources for the hydrologic period of analysis from October 1921 to September 1993 has been estimated for 2020. When information on the production of local supplies was insufficient to estimate a hydrologically varying time series, than a repeating time series of 12 average monthly production values was constructed, based on the 2020 estimated annual total and the derived monthly use pattern for the demand area.

Table B1-7. Explicitly Represented Local Supply Inflows in CALVIN

Urban Demand Area	Local Supply Description	Inflow Node	Avg. Flow KAF/year	Determination/Source
Santa Clara Valley	Surface runoff inflow into local surface water reservoirs of Santa Clara Valley	SR-SC	137 (normal yr) 80 (dry year) 180 (wet year)	IWRP, see file "Region 1-4 Urban Documentation.doc" and file "Santa Clara Inflows.xls" in Software and Data Appendices
Santa Barbara-San Luis Obisbo	Combined local groundwater, surface water, reclamation & desal. Production	D849	71.5	Difference of DWRSIM run 514 deliveries & 2020 maximum target demand, see file "Region 1-4 Urban Documentation.doc" and file "SB_SLO DWR TS.xls" in Software and Data Appendices
San Bernadino Valley	Yield from local groundwater and local surface runoff with Seven Oaks Dam	T2	217.40	SBVWD Regional Facilities Plan, see file "Region 5 Urban Documentation.doc" in Software and Data Appendices
Central MWD	Sum of production from local groundwater, surface water, and reclamation/recycling	C161	1,487.50	2020 projected monthly times series from MWD, see "Region 5 Urban Documentation.doc" and file "Adjusted MWD Demands.xls" in Software and Data Appendices
Eastern & Western MWD	Sum of production from local groundwater, surface water, and reclamation/recycling	C154	316.33	"
San Diego MWD	Sum of production from local groundwater, surface water, and reclamation/recycling	T40	151.22	"
	TOTAL			

Local Supplies Ignored When Small

If the production from local sources is very small (less than 5% of 2020 maximum target demand) then it is usually ignored. Several cases include local groundwater production in some parts of the CALVIN SFPUC urban area, local surface water use in the CVPM urban groundwater pumping areas, and small amounts of urban recycling in interior regions.

URBAN WATER SUPPLY COSTS

Conceptually, urban water supply costs represented in CALVIN are only the variable operating cost of delivering each unit of water (see Appendix G). Capital and overhead costs for existing or planned infrastructure are already "sunk". They are excluded from the input costs so as not to influence the economic optimization of water allocation decisions in CALVIN. Capital and overhead costs for proposed alternatives are also excluded from CALVIN because they are separate issues from the evaluation of net water allocation benefits of alternatives for which CALVIN is used. Such investment costs can be compared to CALVIN's economic results in a subsequent benefit-cost analysis. In reality, because this phase of the project was limited to using existing data, costs numbers used in some parts of the CALVIN model at this time include more than the true variable operating cost. These other costs, for the moment, cannot be separated out without more investigation and research. Some adjustment downwards will have to be made in future. Details of the different operating cost components and their estimates for urban water supply are presented and discussed in Appendix G: Operating Costs.

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DWR (1998c) *The California Water Plan Update, Vol.1, Bulletin 160-98 Public Review Draft.* California Department of Water Resources, Sacramento, CA, January 1998.

See further References in files "Reg 1-4 Urban documentation.doc" and "Reg 5 Urban documentation.doc" in Software and Data Appendices