FIGURE 4.6

I-680

I-580

PLEASANTON

LIVERMORE

DRAINAGE BASIN BOUNDARY

GROUNDWATER SUB-BASIN BOUNDARY

DEEP WELLS- TDS

1,000
500
100

SHALLOW WELL- TDS

1,000
500
100

N

ZONE 7 WATER AGENCY

5997 PARKSIDE DRIVE PLEASANTON CA 94588

DRAWN	GERALD GATES
DESIGNED	GERALD GATES
CHECKED	DAVID LUNN
APPROVED	

WATER RESOURCES ENGINEERING

AVERAGE TDS OF MONITORED WELLS
1997 WATER YEAR

SCALE	1" = 1 MILE
DATE	5 MAY 1998
FILE NO.	H:\smp\FIG4-2.WOR

FIGURE 4.6A
HARDNESS

I-680

I-580

PLEASANTON

LIVERMORE

DRAINAGE BASIN BOUNDARY

GROUNDWATER SUB-BASIN BOUNDARY

SHALLOW WELLS - HARDNESS

750
375
75

DEEP WELLS - HARDNESS

750
375
75

N

ZONE 7 WATER AGENCY
5997 PARKSIDE DRIVE PLEASANTON CA 94588

DRAWN	GERALD GATES
DESIGNED	GERALD GATES
CHECKED	DAVID LUNN
APPROVED	

WATER RESOURCES ENGINEERING

AVERAGE HARDNESS OF MONITORED WELLS
1997 WATER YEAR

SCALE	1" = 1 MILE
DATE	5 MAY 1998
FILE NO.	B.1511 Shp#IS4-3.WOR

FIGURE 4.7
CHLORIDES

I-680

I-580

PLEASANTON

LIVERMORE

DRAINAGE BASIN BOUNDARY

GROUNDWATER SUB-BASIN BOUNDARY

DEEP WELLS - CHLORIDE

300
150
30

SHALLOW WELLS - CHLORIDE

300
150
30

N

ZONE 7 WATER AGENCY
5997 PARKSIDE DRIVE PLEASANTON CA 94588

DRAWN	GERALD GATES
DESIGNED	GERALD GATES
CHECKED	DAVID LUNN
APPROVED	

WATER RESOURCES ENGINEERING

AVERAGE CHLORIDE OF MONITORED WELLS
1997 WATER YEAR

SCALE	1" = 1 MILE
DATE	5 MAY 1998
FILE NO.	H:\smp\FIG4-5.WOR

FIGURE 4.8
NITRATES AS NO3

I-680

I-580

PLEASANTON

LIVERMORE

DRAINAGE BASIN BOUNDARY

GROUNDWATER SUB-BASIN BOUNDARY

DEEP WELLS - NITRATES

60
30
6

SHALLOW WELLS - NITRATES

60
30
6

N

ZONE 7 WATER AGENCY

5997 PARKSIDE DRIVE PLEASANTON CA 94588

DRAWN	GERALD GATES
DESIGNED	GERALD GATES
CHECKED	DAVID LUNN
APPROVED	

WATER RESOURCES ENGINEERING

AVERAGE NITRATES OF MONITORED WELLS
1997 WATER YEAR

SCALE	1" = 1 MILE
DATE	5 MAY 1998
FILE NO.	6-151 | emp\FIG4-4.WOR

represent wells with higher concentrations. Upper aquifer values are represented by red-orange circles and lower aquifer values are represented by blue squares. The 1990-1995 average concentration values are printed next to the symbols. These figures demonstrate that the groundwater quality varies with respect to each of these constituents throughout the basin, and that significant variability exists between some wells that are in close proximity to each other.

Upper Aquifer Water Quality

Figure 4.4 shows that upper aquifer TDS values vary significantly throughout the groundwater basin. The contour map shows that groundwater quality is typically best in areas adjacent to the artificial recharge reaches of the local streams. Along the Arroyo Valle southeast of the mining area, TDS is generally less than 400 mg/L. Along much of the Arroyo Mocho, TDS is generally less than 500 mg/L due to the artificial stream recharging operations.

Groundwater of the Bishop subbasin and the northern area of the Dublin subbasin have TDS values between 400 and 500 mg/L, while the main portion of the Dublin subbasin exhibits TDS in excess of 2,000 mg/L. The lower TDS is believed to be the result of irrigation in northern Dublin and San Ramon with low TDS water supplied by East Bay Municipal Utility District (EBMUD). The 800-1,000 mg/L TDS groundwater in the southern portion of the Dublin subbasin is a result of the groundwater flowing through salt-bearing ancient lake deposits in the south Dublin and northwest Pleasanton areas. This relatively high TDS water is of concern to the extent that it is calculated to move into the shallow aquifer portion of the Bernal sub-basin at about 1 TAF/Y degrading the water in that basin, as was discussed in Section 3.3.

Groundwater in the Camp subbasin contains TDS between 700 and 900 mg/L, and may contain pockets of elevated arsenic concentrations due to the presence of alluvial material eroded from the formations in the Tassajara and Alameda Creak drainage basins. Runoff from these two drainage basins that has historically recharged the groundwater basin may also be a source of arsenic. The Spring subbasin, and to some extent the May subbasin, groundwater has TDS in excess of 2,000 mg/L as a result of inflow from the old marine sediments that occur northeast of Livermore.

The Mocho 2 subbasin is divided horizontally in terms of water quality. To the north, the groundwater exhibits the high TDS characteristics of the Arroyo Las Positas, with concentrations approaching 1,000 mg/L. To the south, the groundwater quality is similar to the Arroyo Mocho water quality, with concentrations barely exceeding 500 mg/L. The beneficial effects of artificial stream recharge are evident in the southern Mocho 2 subbasin.

The East Amador subbasin has poor quality in the north, which is the result of recharge from Arroyo Las Positas, and possibly subsurface inflow from the Camp subbasin. To the

south, in East Amador, the water is of noticeably better quality. This higher quality water is from artificial recharge along the Arroyo Valle. The West Amador subbasin has a similar groundwater quality distribution that is accentuated by the effects of the gravel mining operations that essentially separate the East Amador subbasin from the West Amador subbasin.

The normal flow of groundwater brings the waters of the Dublin, Camp, and West Amador subbasins together in the Bernal subbasin. As a result, the quality in the Bernal subbasin is not simple to characterize as the TDS varies from 300 mg/L to over 2,000 mg/L. To the north, the effect of the higher TDS Dublin subbasin is seen. In the southeast, the lower TDS recharge water from the Arroyo Valle is evident.

Lower Aquifer Water Quality

Water quality in the lower Mocho 2 subbasin varies from 400 to 600 mg/L and exhibits the same profile as the upper aquifer, suggesting that vertical mixing is occurring within the two aquifers. See Section 3.4 for additional information regarding aquifer mixing.

The lower East Amador subbasin has good quality water consisting of 300 to 400 mg/L TDS. This is probably the result of historic recharge from the Arroyo Valle and Arroyo Mocho (Figure 4.5). The lower West Amador subbasin has similar water quality.

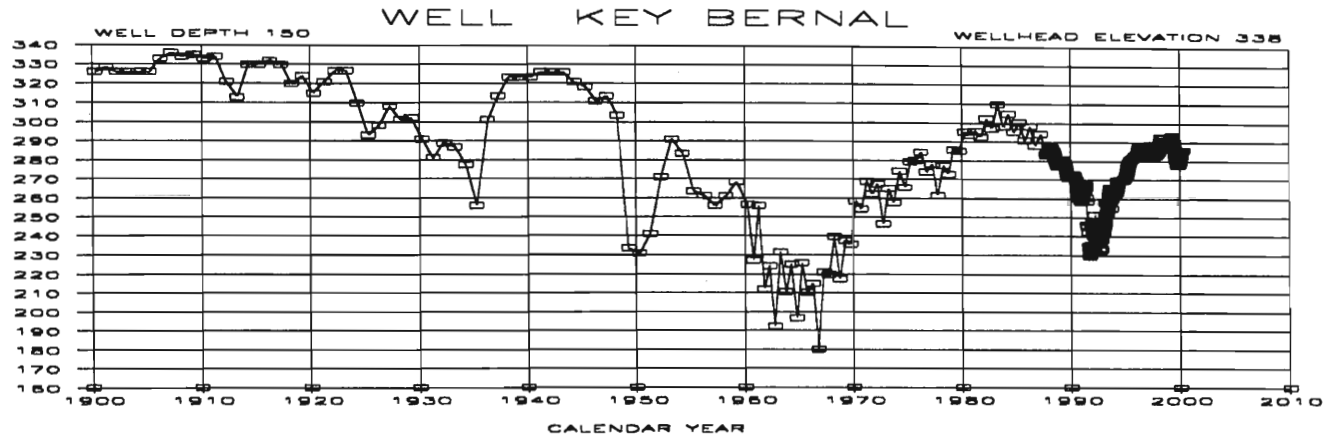
Unlike the upper aquifer in the Bernal subbasin, the lower Bernal subbasin water quality is less variable, ranging from 400 to 700 mg/L TDS. This is most likely the result of lower aquifer pumpage and associated vertical and horizontal mixing.

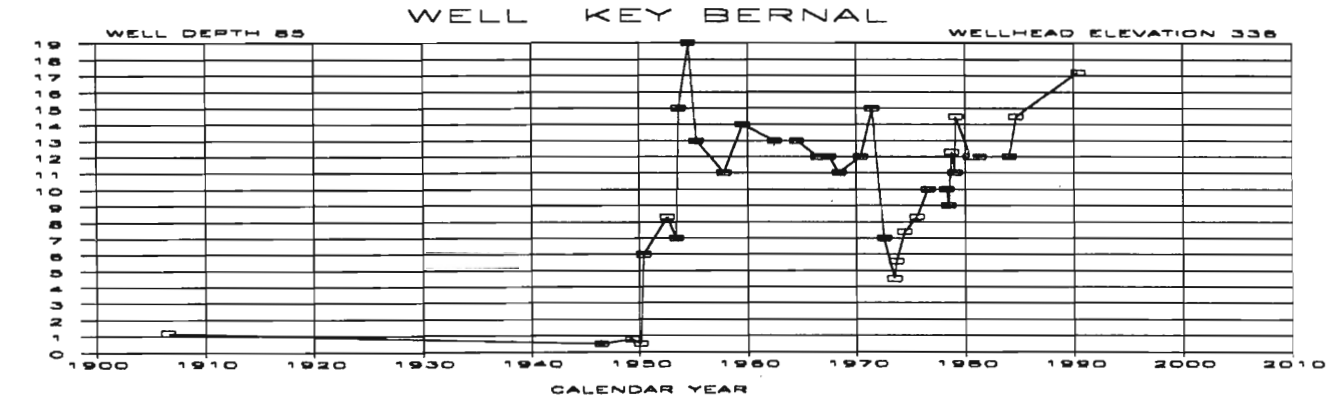
Groundwater Quality Trends

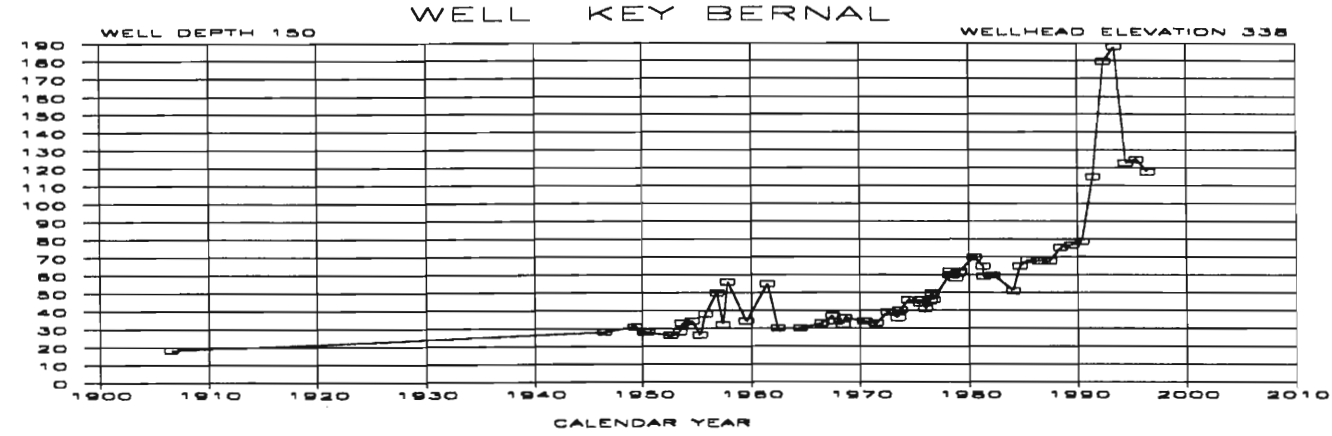
Long-term groundwater quality trends can be difficult to detect. Multiple factors can influence annual groundwater quality including changes in basin level, proximity and volume of groundwater extraction and recharge, and variable recharge water quality. Historic water level and quality records are useful for tracking transport of water within the aquifer and external influences on the groundwater (e.g., streams, mining pits, etc.). Zone 7 tracks trends in key basin areas by routinely producing hydrochemographs of single wells or grouped wells (composite hydrochemographs). Hydrochemographs are time series graphs of individual groundwater water quality constituents.

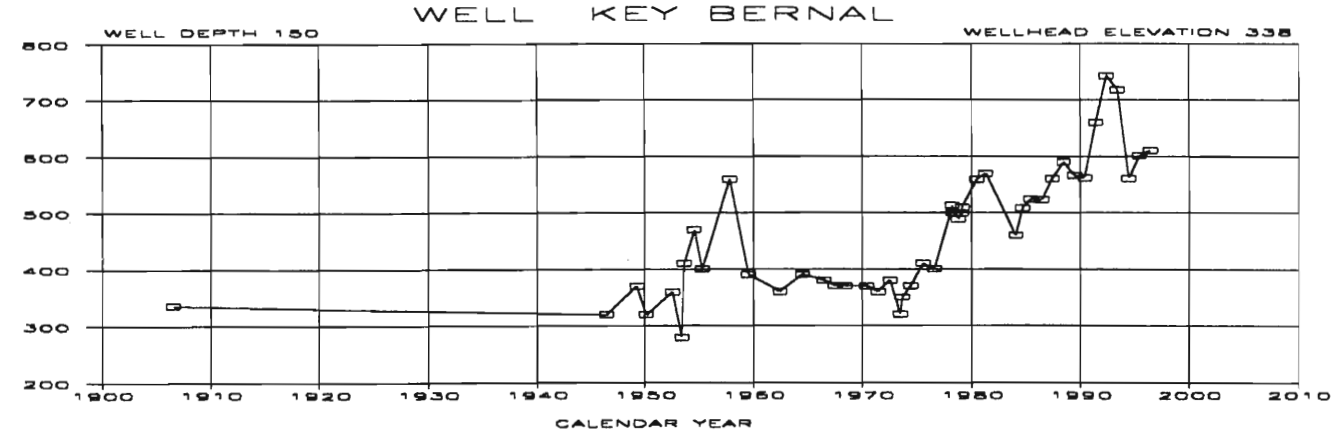
Figure 4.9 contains several composite hydrochemographs representing the Bernal subbasin. Figure 4.10 exhibits hydrochemographs for well 3S/2E 8P 2, a Cal Water well in Livermore, representative of the Mocho 2 subbasin. The data for these two wells span over half a century and show a variable, but overall upward trend in chloride and TDS concentrations. The rate of water quality degradation varies geographically in the basin, and by constituent.

ZONE 7
WATER RESOURCES ENGINEERING
GROUNDWATER HYDROCHEMOGRAPH









WELL: KEY BERNAL

ZONE 7
WATER RESOURCES ENGINEERING
GROUNDWATER HYDROCHEMOGRAPH