NAS7.10571D
NASA-JPL
SSIC No. 9661

PASADENA WATER AND POWER

August 17, 2012

Ms. Judy Huang
United States Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, California 94105

Subject: Perchlorate Contamination in Pasadena's Sunset Reservoir Wells

Dear Ms. Huang:

On May 15 of this year, Pasadena Water & Power (PWP) sent a letter to you accompanied by several documents including a Technical Memorandum (TM). The letter communicated PWP's belief that the current data conclusively demonstrates that the Jet Propulsion Laboratory (JPL) is the dominant source of perchlorate in the Sunset Reservoir Wells.

As you know, on June 23, 2011 of last year there was a meeting in Washington, DC between PWP and the United States Environmental Protection Agency (USEPA) about the source of perchlorate contamination in the Sunset Reservoir Wells. At the meeting, it was proposed that it might be useful to examine the data at least a year after the Monk Hill Treatment System (MHTS) becomes operational, although exactly which data at which locations was not identified.

To facilitate the advancement of a resolution and supplement our May 2012 TM, PWP staff has prepared the attached summary of all of the perchlorate data from all of the relevant locations since the MHTS has been operational. Additionally, we have attached a second TM, which provides additional information on the Stable Isotope Analysis of perchlorate as it impacts source identification and anaerobic biodegradation.

PWP believes that the existing data is quite extensive and more than sufficient to permit determination of JPL as a definite source of perchlorate contamination of the Sunset Reservoir Wells. Further data collection would not be productive and would not change the appropriate conclusion of this issue. Moreover, the need for prompt action is becoming increasingly imperative in order to mitigate further economic losses to PWP and the ratepayers it serves and to protect public health.

PWP believes it is time to set a meeting between the interested parties. The month of September 2012 seems reasonable, and we request that the meeting occur in Pasadena. We would appreciate hearing from you soon.

If you have any questions, please contact Dr. David Kimbrough, Water Quality Manager, at (626) 744-7315.

Sincerely,

Phyllis Currie
General Manager

DK/hs

Enclosures

c: Senator Dianne Feinstein, Senator Barbara Boxer, Representative Adam Schiff, Representative Judy Chu, Steve Slaten (NASA), Jeff O'Keefe (DPH), Juli Osborne (DTSC), Tony Zampiello (RBMB), Mic Stewart (MWDSC), Jean-Lou Chameau (California Institute of Technology)

PASADENA
Water&Power

TECHNICAL MEMORANDUM ON THE MONK HILL TREATMENT SYSTEM AFTER ONE YEAR OF OPERATION

AUGUST 2012

Monk Hill Treatment System

On June 23, 2011 there was a meeting between Pasadena Water and Power (PWP), the United States Environmental Protection Agency (USEPA), and the National Aeronautics and Space Administration (NASA) about the Sunset Reservoir Wells and the source of contamination there. At that meeting, USEPA suggested the issue could not be examined until there was at least a year or two of data to examine following the start-up of the Monk Hill Treatment System (MHTS). At the meeting it was not identified what data would be examined or how it would be assessed. There appears to be at least three sets of data that might conceivably be relevant, the data from Monk Hill Sub-Basin wells west of the Arroyo Seco where the sources of perchlorate and VOCs are located, the data of the production from Monk Hill Sub-Basin wells on the east side of the Arroyo Seco, and wells in the Pasadena Sub-Basin, including those around the Sunset Reservoir Wells. The location of the Monk Hill Sub-Basin Wells is shown in Figure 1.

Censored Data

Results of perchlorate reported as either zero or <DLR (less than the Detection Limit for Reporting which is 4 □g/L) were assigned an arbitrary value of 0.4 □g/L for graphing and statistical purposes.

Operable Units

PWP's Monk Hill wells were in operation until June 1997 when the Arroyo Well was taken out of operation because of the detection of perchlorate. The other three wells (Well 52, Ventura, and Windsor) were also taken out of operation in January of 2002. The four Monk Hill wells were rehabilitated and the Monk Hill Water Treatment Plant was constructed, which together constituted the Monk Hill Treatment System (MHTS) which is part of Operable Unit 3, OU-3. In July of 2011, the Arroyo Well was returned to service and in October of 2011 Ventura Well was also returned to service. Both Wells were shut down in April 2012 due to electrical problems and returned to service in June of 2012. Operable Unit 2 (OU-2, which removed volatile organic compounds (VOCs) from the soil, came into operation as a pilot facility in 1998 and expanded operations by adding three wells in 2002, Operable Unit 1 (OU-1) came into operation in early 2005, which removed both VOCs and perchlorate from the groundwater.

La Cañada – Flintridge Production Wells

The wells furthest west and upgradient of the MHTS are the production wells of the La Cañada Irrigation District (LCID) and Valley Water Company (VWC). Located approximately 1 km (0.6 miles) west of Jet Propulsion Laboratories (JPL), which are all perforated approximately between 200 and 350 m (600 – 1,000 ft) above mean sea level (AMSL) and the concentrations range <DLR to 7 □g/L with median concentration in the 2 – 5 □g/L range (see Table 1). The concentration of perchlorate does not appear to change at all over time (Figure 2). <u>There does not appear to be any change in concentration based on changes in operation of any of the three operable units.</u>

La Cañada – Flintridge Monitoring Wells

There are a number of monitoring wells operated by NASA on and off of the facility. The monitoring wells furthest west and upgradient of the MHTS are MW-14 and MW-21. Figure 3 shows the concentration of perchlorate in four of the monitoring well locations in the La Cañada-Flintridge area (MW-14-1, MW-14-2, MW-21-1, and MW-21-2). MW-14 is located on the western most edge of the JPL property and MW-21 is located off of the facility 500 m (0.3 miles) south of JPL property line. Both of these wells have five sampling ports all of which are perforated approximately between the same altitudes as the upgradient production wells and have perchlorate concentrations somewhat less than the upgradient wells (see Table 1). Figure 3 shows the concentration of perchlorate in four of these wells (VWC Well #1, VWC Well #2, VWC Well #3, and LCID #1). The concentration of perchlorate does not appear to change at all over time except for MW-21-1, which appears to be decreasing since 1997. There does not appear to be any change in concentration based on changes in operation of any of the three operable units.

JPL Monitoring Wells West of the Arroyo Seco

The "bellwether" well for the JPL facility is MW-7, which is located very close to main disposal areas and has had the highest recorded concentrations for perchlorate and VOCs and has a sampling depth of about 320 m (963 ft) (Table 3). The maximum measured value for perchlorate was 13,300 □g/L in the summer of 2005, but has since declined dramatically. MW-7, MW-16, and MW-24-1 are all in the disposal area, but MW-3-2 is just outside the eastern edge of the JPL facility and similar results have been obtained. With the operation of OU-1, the concentrations have declined dramatically at these wells.

However, not all sampling locations showed this downward trend. MW-3-2, MW-4-2, MW-6, and MW-12-2 all show an upward trend in perchlorate concentration over time, as can be seen in Figure 4. MW-3-3, MW-4, and MW-12 are all east of the disposal near the Arroyo Seco while MW-6 is near the western boundary of the JPL facility not far from MW-14.

The decline in concentration of perchlorate in the monitoring wells that had very high concentrations of perchlorate (MW-7, MW-16, and MW-24) and were located near the disposal sites were clearly associated with the operation OU-1 which began in 2005. Other monitoring wells, located further from the disposal sites and having overall lower concentrations of perchlorate, have not shown decreases, whether located west (MW-6) or east. Interestingly MW-3-2 and MW-3-3 show exactly inverted curves, with the concentration dropping to <DLR for one and rising above it for the other in late 2001, early 2002. This coincides with the Monk Hill Wells being taken out of operation.

East Monk Hill Sub-Basin Production Wells

The production wells to the east of the Arroyo Seco resemble the low concentration wells east of the disposal site in that the concentrations of perchlorate tend to be level or increasing. Arroyo Well, since start-up in July of 2011, has seen a decline in the perchlorate concentration from about 100 □g/L to approximately 40 □g/L in April of 2012. Ventura Well has shown very little, if any, change in the concentration of perchlorate, it has been around 5 □g/L since 1997 and Las Flores Water Company (LFWC) Well 2 shows the same concentration over the same period (Figure 6 and Table 3). The curves for Ventura Well and LFWC #2 are nearly identical and neither shows any change when any of the operable units came or went out of operation. Concentrations of perchlorate at the two Lincoln Avenue Water Company (LAWC) Wells have been steadily increasing since 2004 although LAWC #5 showed a precipitous decline after 2008, but LAWC #3 showed an increase in the same period. Was the fact that the three Monk Hill wells were shut down in 2002 the cause of this increase? It is difficult to say. However, it would appear that the operation of OU-1 and OU-2 did not have any impact on the perchlorate concentrations of these production wells.

East Monk Hill Sub-Basin Monitoring Wells

Some of the monitoring wells east of the Arroyo Seco MW-17-2, MW-17-3, and MW-18-3 showed a dramatic increase in concentrations of perchlorate after 2002 when the Monk Hill wells were shut down (Figure 7, Table 3) while MW-19-2 and MW-19-3 showed little or no change. MW-18-4 shows no clear long term pattern with periodic increases and decreases in perchlorate concentration. The lowering concentrations seen on the JPL site do not appear to have impacted the monitoring or production wells east of the Arroyo Seco; however, shutting off the Monk Hill Wells seems to have resulted in increasing concentrations in some monitoring wells, but not others.

Sunset Reservoir Wells

The perchlorate concentration in the five Sunset Reservoir Wells appear to have very steady concentrations and have concentrations higher than those wells found in the La Cañada Flintridge area, but lower than those in JPL and Monk Hill areas (Figure 7 and Table 4). The shutting down of the Monk Hill Wells in 2002 and starting up of OU-1 do not appear to have had any impact on the concentrations of perchlorate either way, although there is a brief increase in concentration in perchlorate in all wells in 2005. The return to operation of the Arroyo and Ventura Wells likewise had no impact either way as well.

Similarly, the concentrations in the four upper ports at MW-25 show consistent concentrations of perchlorate, also higher than the La Cañada Flintridge monitoring wells, but higher than that found in the Monk Hill production and JPL monitoring wells. The exception to this is MW-25-5 which is marked by very low concentrations most of the time from 2005 to 2012, (mostly below the reporting limit), but with periodic jumps in concentration to well above the concentration found in the other ports.

This is not really surprising for two main reasons. The travel time for water moving from the Monk Hill Sub-Basin to the western Pasadena Sub-Basin is anywhere from seven to 21 years (Figure 10). Further, the Pasadena Sub-Basin is considerably longer, wider, and deeper and has a considerably larger volume of water in it (Figure 11). Thus, it would be entirely reasonable to expect that even if the Monk Hill wells were shut down for nine years (2002 – 2011) that there would be no measurable impact upon the concentrations of perchlorate in the Sunset Reservoir Wells even if there once had been containment. However, these results are entirely consistent with PWP's contention that no containment had ever been achieved and that the steady levels of perchlorate over time represent the fact that there was as much blending of water from La Canada Flintridge with the Monk Hill area water before the shutdown of Monk Hill wells and after.

Conclusions

Given the differences in volume between the Monk Hill Sub-Basin and the Pasadena Sub-Basin, the length of time needed for water to travel between areas where production or monitoring wells are operating, the many changes in how these aquifers have been managed, OU-1, OU-2, and OU-3 on and off at different times, and the lack of any historic changes in the perchlorate concentration in the Sunset Reservoir area wells, it is unreasonable to anticipate any measurable changes in perchlorate concentration for anywhere from seven to 20 years.

Figure 1

Location of Production and Monitoring Wells in the Monk Hill Sub-Basin

Figure 2

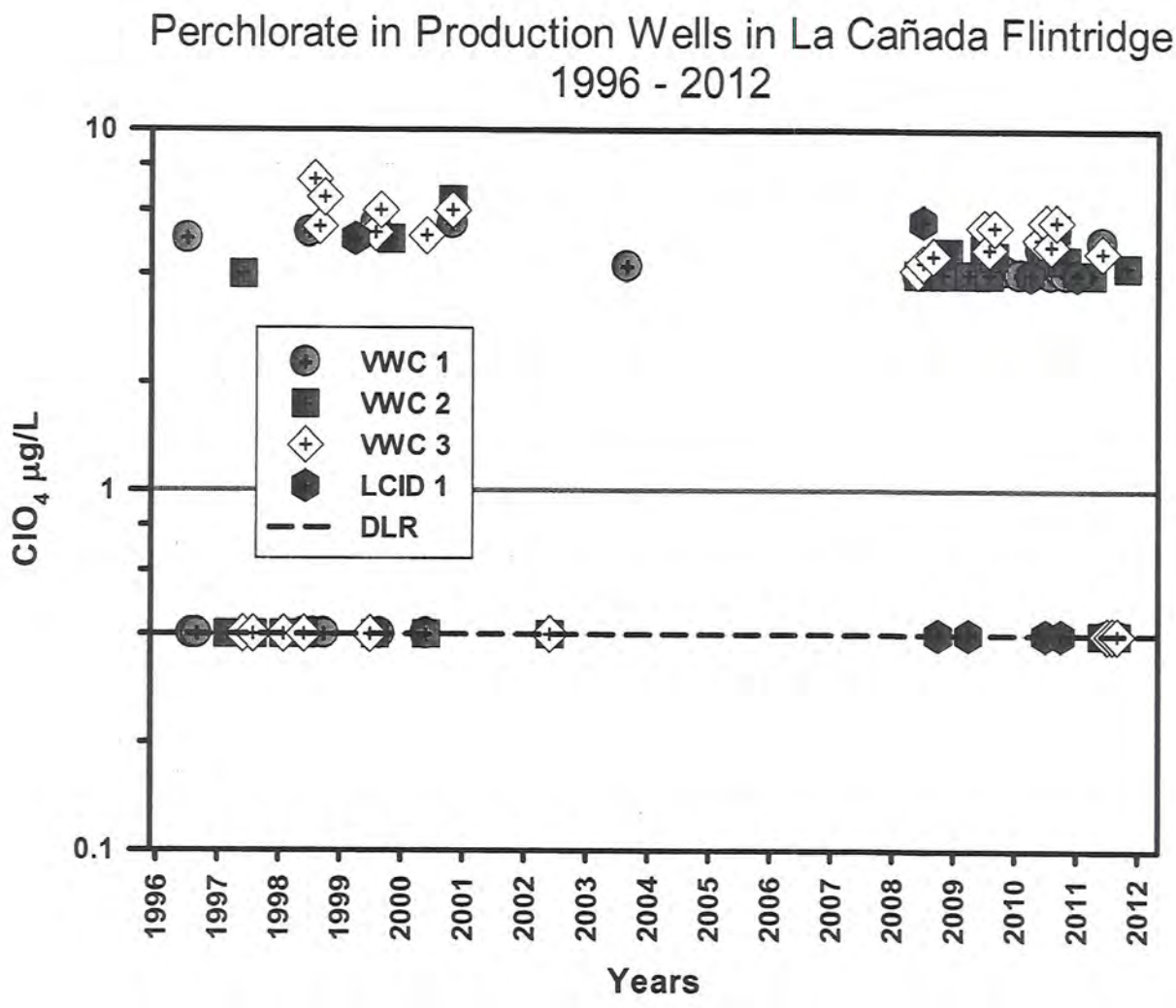


Figure 3

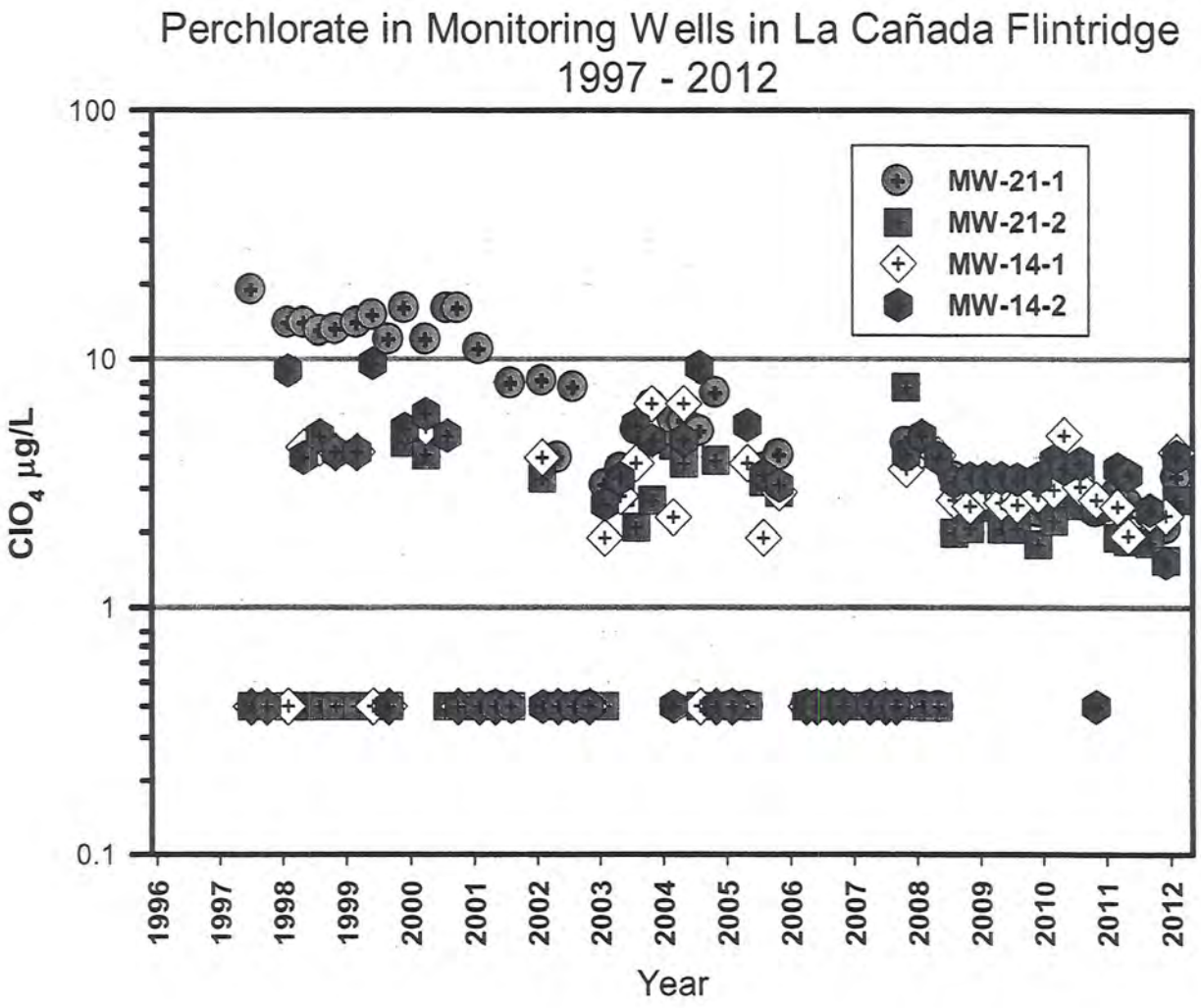

Perchlorate in Monitoring Wells in La Cañada Flintridge
1997 - 2012
100
10
1
0.1
ClO4 µg/L
MW-21-1
MW-21-2
MW-14-1
MW-14-2
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Year

Figure 4

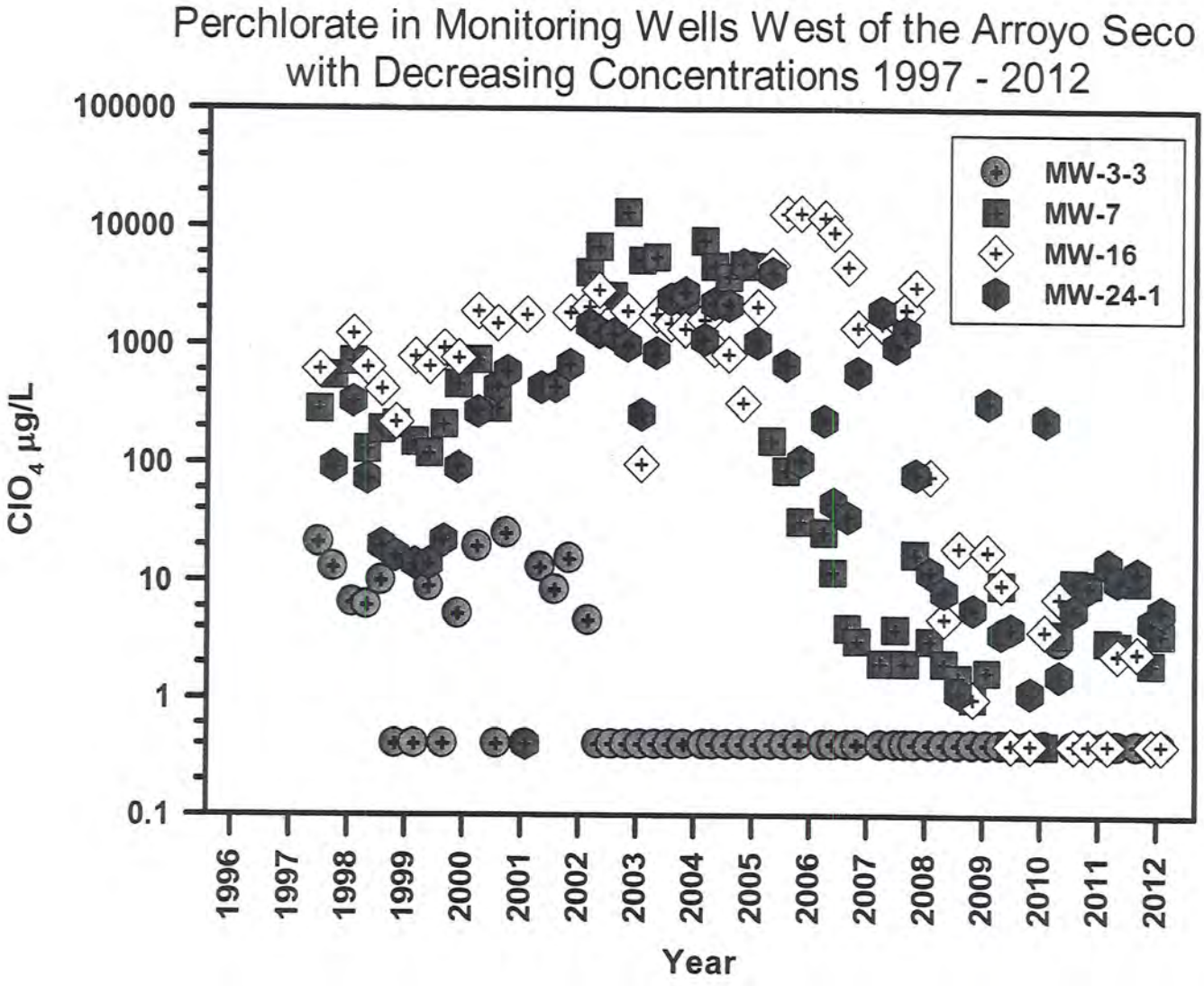

Perchlorate in Monitoring Wells West of the Arroyo Seco
with Decreasing Concentrations 1997 - 2012
100000
10000
1000
100
10
1
0.1
ClO4 µg/L
MW-3-3
MW-7
MW-16
MW-24-1
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Year

Figure 5

Perchlorate in Monitoring Wells West of the Arroyo Seco with Increasing Concentrations 1997 - 2012

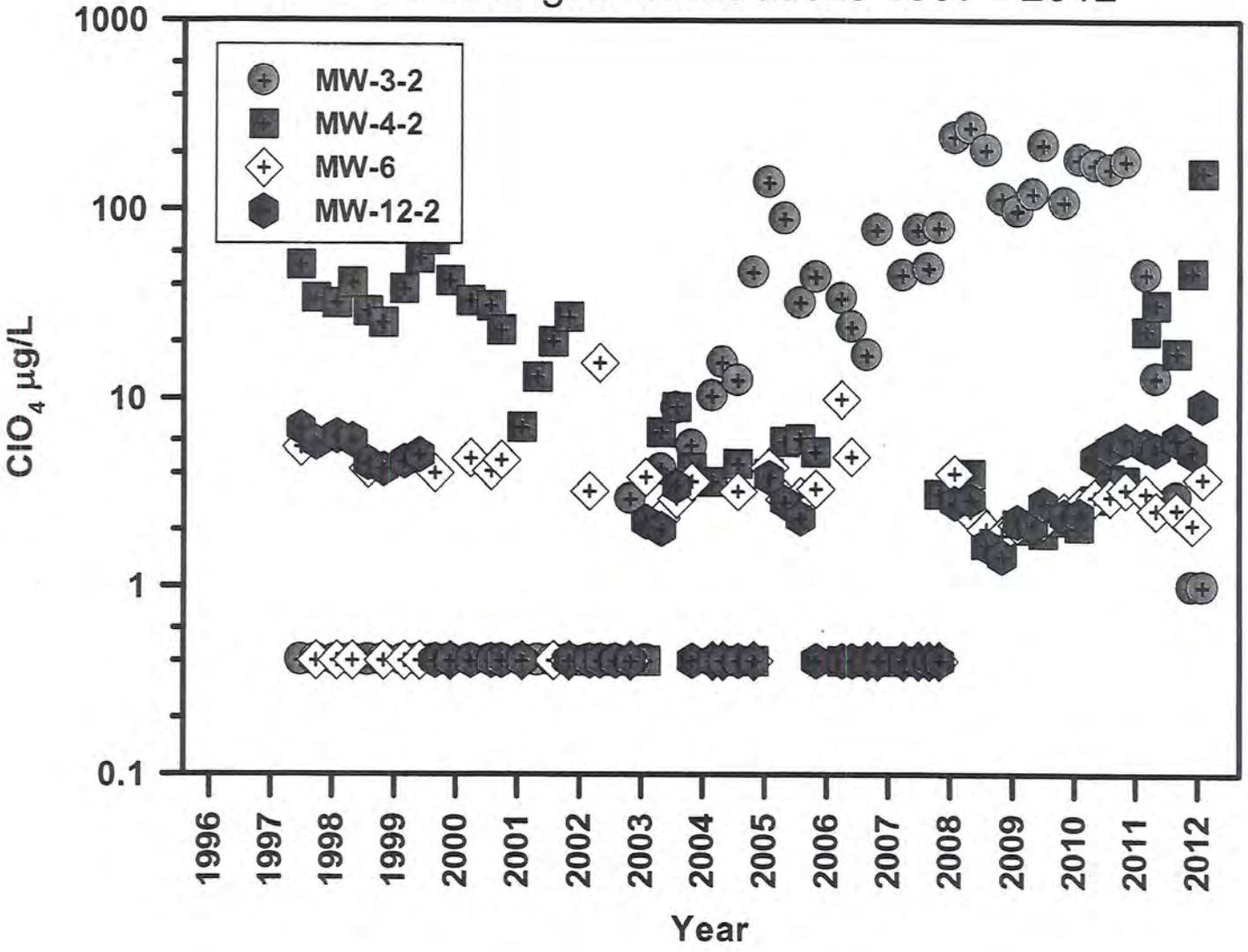


Figure 6

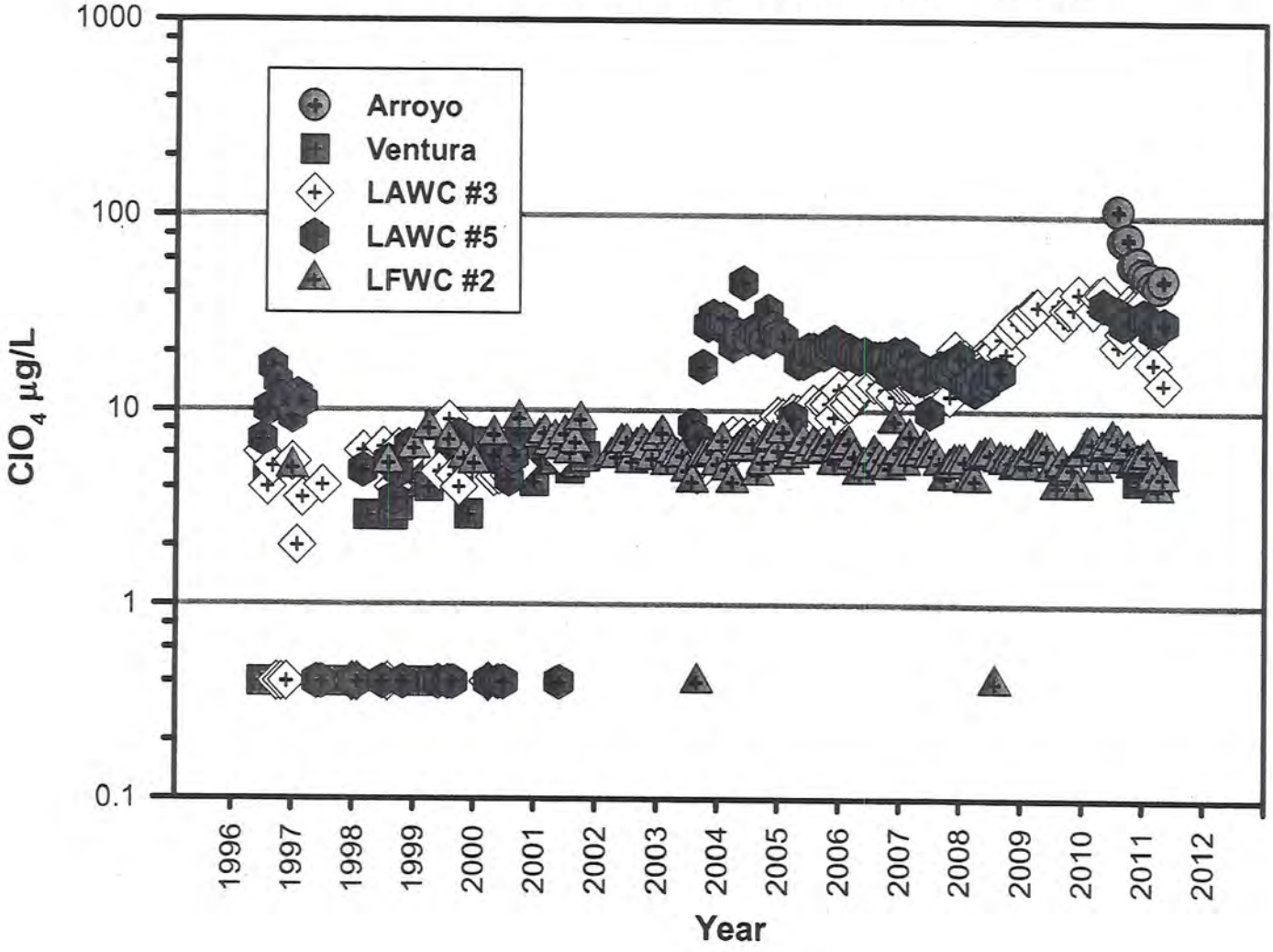

Perchlorate in Production Wells East of the Arroyo Seco in the Monk Hill Sub-Basin 1997 - 2012
1000
100
10
1
0.1
ClO4 µg/L
Arroyo
Ventura
LAWC #3
LAWC #5
LFWC #2
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Year

Figure 7

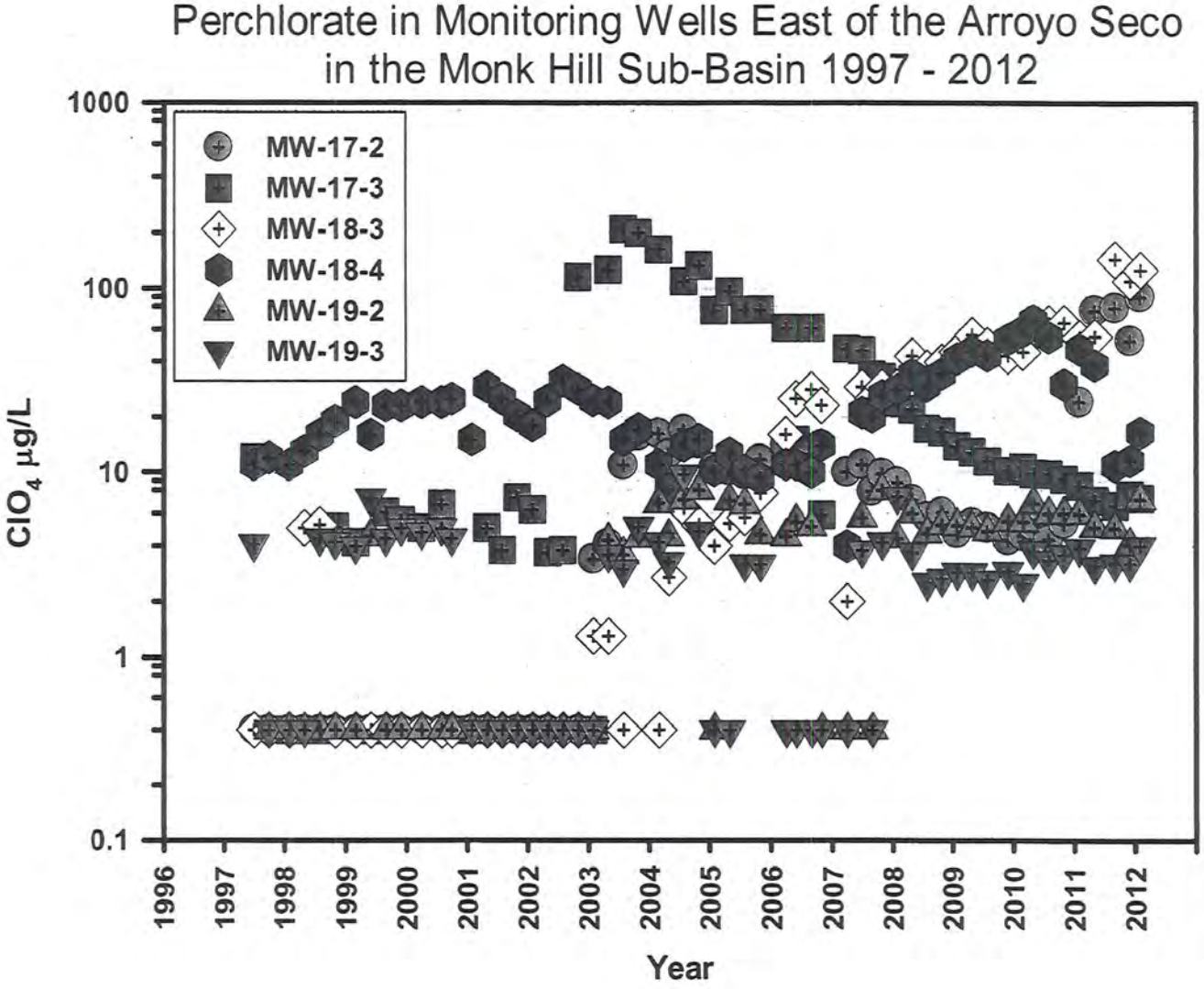

Perchlorate in Monitoring Wells East of the Arroyo Seco in the Monk Hill Sub-Basin 1997 - 2012
MW-17-2
MW-17-3
MW-18-3
MW-18-4
MW-19-2
MW-19-3
1000
100
10
1
0.1
ClO4 µg/L
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Year

Figure 8

Perchlorate in Production Wells in the Sunset Reservoir Area in the Pasadena Sub-Basin 1997 - 2012

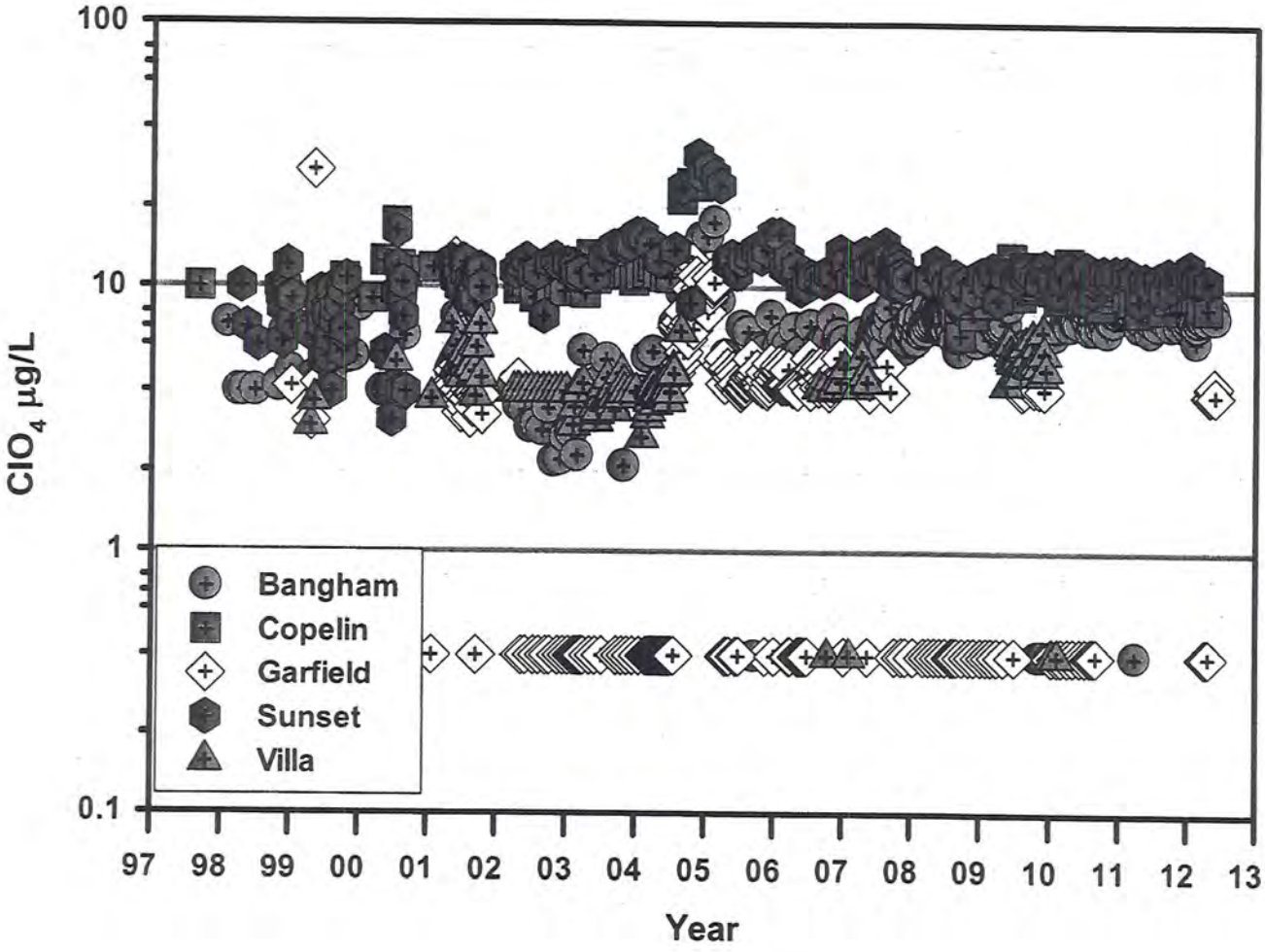


Figure 9

Perchlorate in Monitoring Well 25 in the Sunset Reservoir Area 2005 - 2012

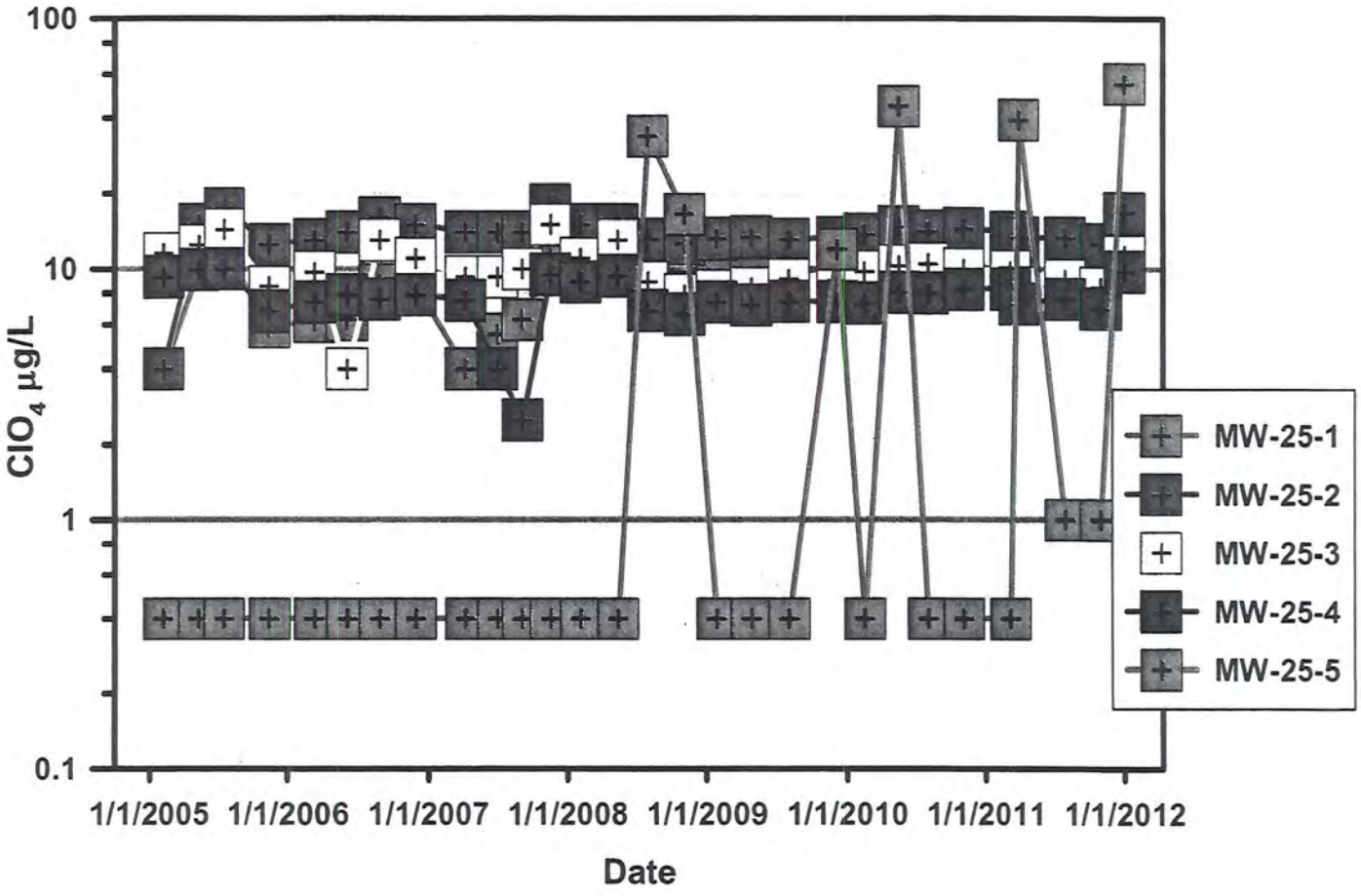
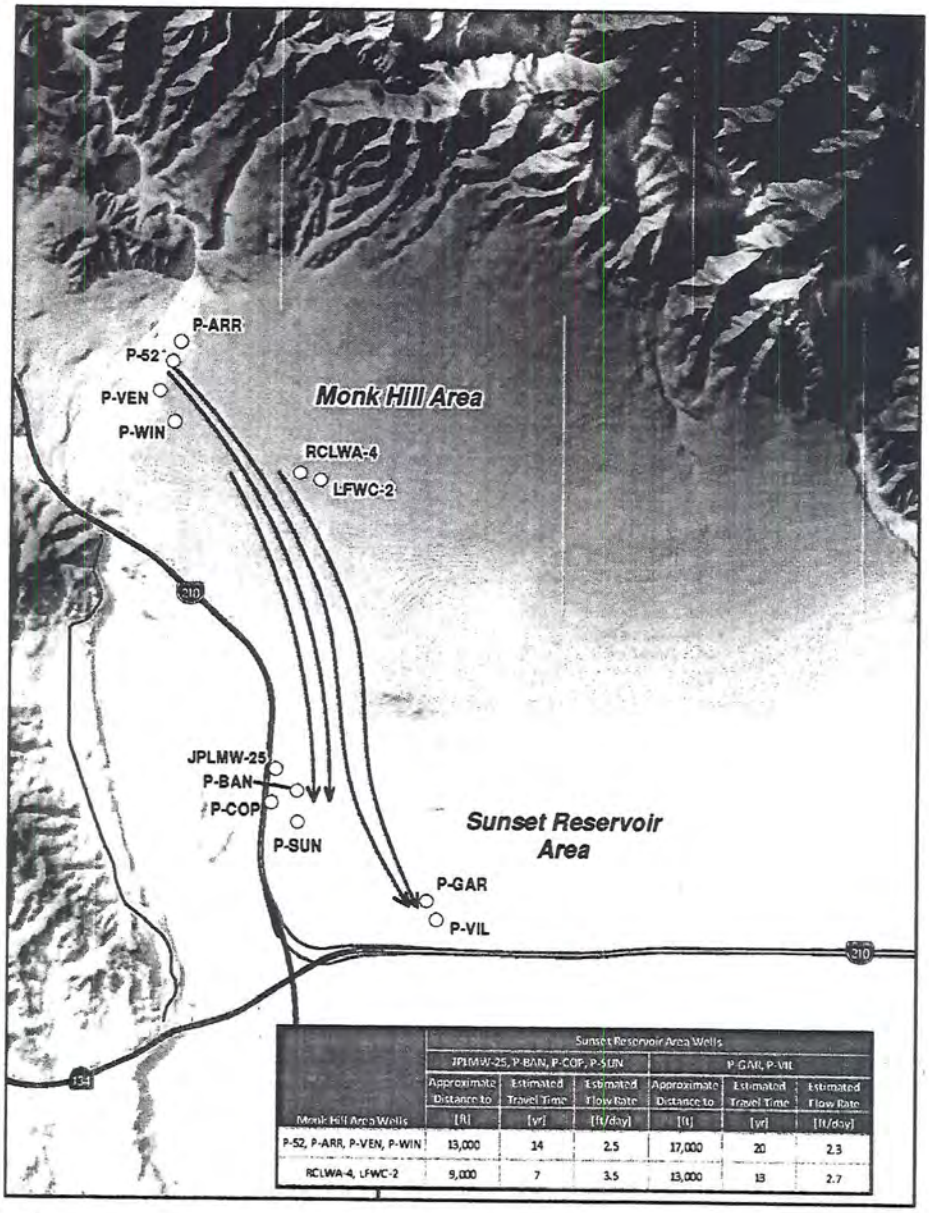


Figure 10

Transit Paths and Time for Waters in the Raymond Basin

CITY OF PASADENA



Monk Hill Area Wells	Sunset Reservoir Area Wells: JPLMW-25, P-BAN, P-COP, P-SUN — Approximate Distance to [ft]	Estimated Travel Time [yr]	Estimated Flow Rate [ft/day]	P-GAR, P-VIL — Approximate Distance to [ft]	Estimated Travel Time [yr]	Estimated Flow Rate [ft/day]
P-52, P-ARR, P-VEN, P-WIN	13,000	14	2.5	17,000	20	2.3
RCLWA-4, LFWC-2	9,000	7	3.5	13,000	18	2.7

8-Jun-12

Prepared by: JDK

Map Projection:
UTM 1927, Zone 11

NORTH

0 4,000 8,000 Feet

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Figure 11

Geological Cross-Section of the Raymond Basin

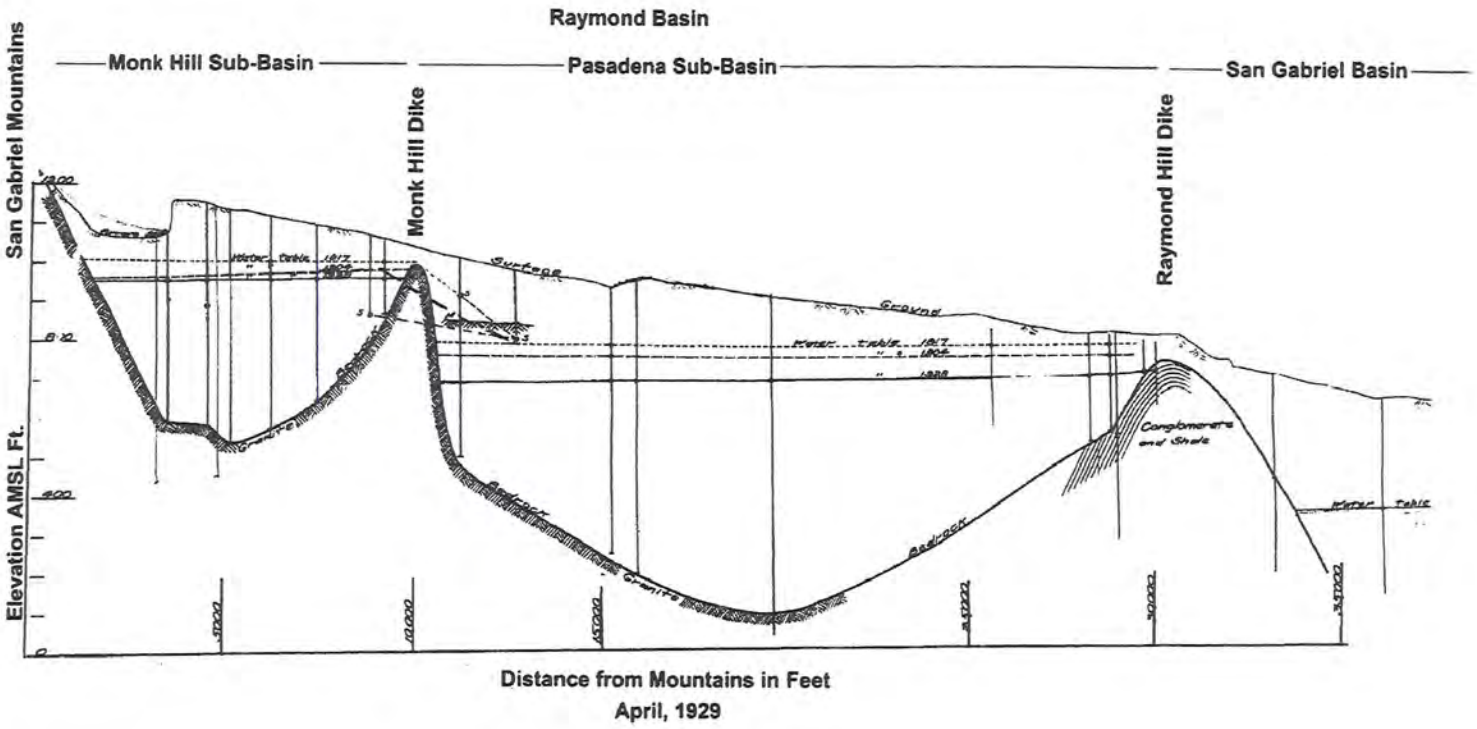

Table 1

Production and Monitoring Well Characteristics for La Canada – Flintridge

1997 - 2011

Well	Altitude		ClO_4	
	Top Perforation	Bottom Perforation	Mean	Median
	Ft. AMSL	Ft. AMSL	µg/L	µg/L
VWC 1	1007	730	3.4	4.0
VWC 2	1006	711	3.0	4.0
VWC 3	970	599	3.5	4.1
VWC 4	958	708	2.5	2.2
LCID 1	970	690	2.7	4.0
MW-14-1	963		1.9	1.9
MW-14-2	893		2.5	3.2
MW-14-3	788		4.8	5.6
MW-14-4	715		1.9	0.4
MW-14-5	630		0.4	0.4
MW-21-1	968		3.6	2.9
MW-21-2	898		1.2	0.4
MW-21-3	818		1.4	0.4
MW-21-4	748		1.3	0.4
MW-21-5	688		1.8	0.4

Table 2

Monitoring Well Characteristics for JPL West of the Arroyo Seco

1997 - 2011

Well	Altitude		ClO_4	
	Top Perforation	Bottom Perforation	Mean	Median
	Ft. AMSL	Ft. AMSL	µg/L	µg/L
MW-3-2	845		57	16
MW-3-3	751		3.5	0.4
MW-4-2	841		17	5.9
MW-6	968		2.3	2.0
MW-7	963		1,470	130
MW-12-2	857		2.3	0.9
MW-16	982		1,960	1,270
MW-24-1	921		696	6.2

Table 3

Production and Monitoring Well Characteristics East of the Arroyo Seco

1997 - 2011

Well	Altitude		ClO_4	
	Top Perforation	Bottom Perforation	Mean	Median
	Ft. AMSL	Ft. AMSL	µg/L	µg/L
Arroyo*	966	469	62	54
Ventura*	850	610	4.7	5.0
LAWC 3	740	602	17	19
LAWC 5	814	648	8.1	7.4
LFWC 2*	1160	660	5.9	6.0
MW-17-2	820		6.3	5.0
MW-17-3	720		37	12
MW-18-3	799		17	5.1
MW-18-4	659		24	22
MW-19-2	748		3.0	4.4
MW-19-3	748		2.7	2.9

* includes 2012 data

Table 4

Production and Monitoring Well Characteristics in Sunset Reservoir Area

1997 - 2012

Well	Altitude		ClO_4	
	Top Perforation	Bottom Perforation	Mean	Median
	Ft. AMSL	Ft. AMSL	µg/L	µg/L
Bangham	378	258	7.0	7.4
Copelin	537	367	11	10
Garfield	522	222	3.5	4.2
Sunset	689	371	11	11
Villa	584	35	4.3	4.2
MW-25-1			8.6	9.2
MW-25-2			14	14
MW-25-3			10	9.8
MW-25-4			7.7	7.6
MW-25-5			7.3	0.4