Cleath-Harris Geologists, Inc.
11545 Los Osos Valley Road, Suite C-3
San Luis Obispo, California 93405
(805) 543-1413

Technical Memorandum

Date: July 29, 2009

From: Spencer Harris

To: ISJ Group

SUBJECT: Los Osos Creek Valley Yield Evaluation

This memorandum discusses the potential for surplus water in the Los Osos Creek Valley, and options for groundwater development by the community water purveyors. Surplus water is defined herein as the difference between sustainable yield and current water use. The scope of work was performed in accordance with sub-task 5 of the ISJ consulting agreement dated December 17, 2008.

Current Conditions

Current water use in the creek valley has been estimated at 800 acre-feet per year (AFY) for irrigation and 75 AFY for rural residential use. Recharge to the aquifers underlying the creek valley comes mainly from stream flow seepage. Hydrographs for wells in the creek valley show seasonal fluctuations of up to 40 feet, but show no overall trend in water level rise or decline. Spring water levels are up to 15 feet lower due to the current drought, but were at historically normal (full) levels as recently as 2005. These hydrograph patterns indicate that the existing sources of recharge are sufficient to fully replenish the creek valley aquifer over a normal hydrologic cycle under current water use conditions.

Los Osos Creek Flow

Los Osos Creek drains the Clark Valley and Los Osos Creek Valley, with a watershed area of 7.27 square miles at the gage station located under the bridge on Los Osos Valley Road. Records are available for 19 years between 1976 and 2002 (summary table attached). The average flow on Los Osos Creek at the gage is 3,769 AFY. Median flow is 2,110 AFY. The range of measured flows are from no flow (2002) to over 19,270 acre-feet (partial flow for 1995). More recent raw flow data has been collected by the County but has not yet been processed.

Recharge from Stream Seepage

Seepage from Los Osos Creek into the alluvial deposits recharges the groundwater basin aquifers. The U.S. Geological Survey (Yates and Wiese, 1988) estimated stream seepage during normal years at 600 AFY. The 2008 EFH basin model estimated stream seepage under current conditions at 665 AFY (Cleath & Associates, 2008), while the SEAWAT model estimates stream seepage under current conditions (using current production distribution) at 640 AFY.

Historical Observations

Stream flow data collected by County personnel between February 24 and June 12, 1986 indicated an average Los Osos Creek seepage rate of 0.55 cubic feet per second (cfs) into the valley alluvial deposits upstream of the gage (Morro Group, 1987). The 1985-86 rainfall year was above average in precipitation (20.39 inches compared to an average of 19.17 inches at Station #144, located less than a mile west of the stream gage). By February 24, 1986, the creek valley alluvium upstream of the gage had been substantially filled, as gaged flows had already reached over 150 cfs (averaging 300 cfs) for 9 consecutive days earlier that month. The stream seepage capacity upstream of the gage during the late fall and early winter months, when ground water levels are still low, is likely to be much greater than the 0.55 cfs measured in Spring 1986.

February 2009 Stream Flow Survey

Cleath-Harris Geologists conducted three stream flow surveys in February 2009. On February 6, the creek was dry upstream of the valley alluvial deposits. There were some shallow pools in the channel west of the horse corrals (Gorby site), but otherwise the creek bed was dry through the gage site. No inspection of the creek downstream of the gage site was performed.

On February 13, flow in the creek channel upstream of the valley alluvial deposits was measured at 0.38 cfs. All surface flow had seeped in upstream of the first horse corral, with the channel then dry through the gage. At the gage site, on the north side of the bridge, a drainage culvert was discharging 0.13 cfs into the creek. Flow from the drainage culvert at the bridge was monitored downstream, and continued relatively undiminished (averaging 0.12 cfs) through the last exposure of the perching clay layer along the creek bank, approximately 1,500 feet downstream of the bridge. It is evident that there is very little seepage over this reach. The creek ran dry within 200 feet of the edge of the perching clay. No inspection of the creek further downstream was performed.

On February 16 (24-hour precipitation reported at 0.53 inches for Morro Bay through 10 AM) flow in the creek channel upstream of the valley alluvial deposits was measured at 1.01 cfs. Stream flow was seeping completely into the stream bed west of the horse corrals. Evidence of higher flows overnight were noted by the debris pattern, which had extended surface flows a few hundred feet

further downstream. Discharges from the culvert on the north side of the bridge were observed. No inspection of the creek further downstream was performed.

Creek Valley Yield

The SEAWAT model was used to estimate the maximum potential yield of the basin under VPA2b wastewater project disposal. Rather than restricting production shifts to the existing purveyor wells in the Urban area (see memo on Urban area yield), new wells adjacent to and in the creek valley were simulated. Two scenarios were modeled, one with three new wells at the east edge of the Urban Area and a second scenario which included five new creek valley wells.

These scenarios were chosen by Cleath-Harris Geologists as hypothetical examples of creek valley water development, and do not necessarily reflect scenarios that will be undertaken by the water purveyors. There are a number of factors that must be taken into account by the water purveyors when determining any potential future creek valley water development, including but not limited to, ownership of land parcels, location of other water infrastructure, regulatory permitting requirements, allocation of water resources, and cost.

Urban Area Fringe Scenario

Three wells were inserted into the SEAWAT model along the east edge of the Urban area, west of Los Osos Creek. Results of the model simulation indicate that basin yield can be increased by 250 AFY under a VPA2b wastewater project (from 3,150 AFY to 3,400 AFY). There is an increase in stream seepage recharge from Los Osos Creek of approximately 180 AFY.

A total of 350 AFY of production is shifted from existing purveyor wells to the Urban area fringe well sites, along with 250 AFY of new production. Under optimized yield, the model favors a greater distribution of pumping south of Los Osos Valley Road. One example of the distribution of optimized purveyor production under VPA2b, with expansion wells in the Urban area fringe, is listed below in Table 1.

Table 1
Potential purveyor well production under wastewater project conditions with VPA2b disposal and Urban area fringe wells west of Los Osos Creek

Purveyor	Well	Production (AFY)
GSWC	Upper Aquifer	700
	Lower Aquifer	200
LOCSD	Upper Aquifer	485
	Lower Aquifer	215
S&T	Upper Aquifer	100
SHARED	Urban Area Fringe	600
PURVEYOR TOTAL		2,300

Note: Other optimum yield pumping distributions are possible. The actual distribution of well production would be subject to purveyor agreement.

Creek Valley Expansion Scenario

Five additional wells were inserted into the creek valley portion of the basin model for the maximum basin yield scenario. As with the Urban area fringe wells, the model favored a greater distribution of pumping in the southern creek valley.

The optimized basin yield simulated by the SEAWAT model, with no producing wells exceeding the 250 mg/l chloride threshold, is 3,650 AFY. One example of the distribution of optimized purveyor production under VPA2b, with Urban area fringe wells and additional creek valley production, is listed below in Table 2.

Table 2
Potential purveyor well production under wastewater project conditions with VPA2b disposal and new wells east and west of Los Osos Creek

Purveyor	Well	Production (AFY)
GSWC	Upper Aquifer	687.5
	Lower Aquifer	162.5
LOCSD	Upper Aquifer	535
	Lower Aquifer	215
S&T	Upper Aquifer	100
SHARED	Urban Area Fringe	250
	Los Osos Creek Valley wells	600
PURVEYOR TOTAL		2,550

Note: Other optimum yield pumping distributions are possible. The actual distribution of well production would be subject to purveyor agreement.

Surplus Water Availability

The SEAWAT model indicates that 600 AFY of additional groundwater can be pumped from the creek valley, for a total creek valley production of 1,475 AFY. The recharge for this level of production comes primarily from stream seepage, which is estimated at 1,013 AFY.

The current basin model simulates changes in water quality over time for sea water intrusion, but is effectively steady-state in terms of flow (no seasonal fluctations in head). Stream flow is simulated in the SEAWAT model with the same RIVER package used in the steady-state EFH model, which allows for constant seepage controlled by aquifer permeability and stream bed conductance. Therefore, although the model estimates average stream seepage at approximately 1,000 AFY (equivalent to 1.38 cfs continuous flow) for maximum yield simulations, actual stream seepage during periods of flow would have to be significantly more to offset a lack of seepage recharge during seasonal dry periods and drought.

The key to surplus water availability in the creek valley is the efficiency of the groundwater system in capturing storm runoff before it flows out to the bay. Watershed runoff can increase significantly after a threshold value of precipitation has offset the watershed's soil moisture deficit. Other dynamics, including storm intensity, alluvial water levels and stream channel seepage capacity

combine to produce a unique response to runoff for each storm event. Effects of a prior years runoff can also carry over to the following season through base flow.

Due to the transient nature and relatively short duration of seasonal flows above base flow, channel seepage capacity is a critical variable in identifying the upper limits of potential recharge. One of the objectives of the 2009 stream flow survey was to evaluate the maximum seepage capacity of the stream channel, but there has been insufficient precipitation this season to determine that value. A channel seepage capacity on Los Osos Creek of at least 10 cfs would likely be needed to provide sufficient recharge during wet periods to validate the availability of surplus water indicated by the basin model.

Water Quality

Sub-task 5 of the scope of work included sampling up to five wells from participating private wells in the creek valley. Several contacts were made with creek valley wells owners, none of whom would commit to participating in the water quality survey. The following summarizes available information for mineral content and nitrate water quality in the vicinity of the hypothetical new wells sites in the Urban area fringe and the creek valley. More detailed analytical data is available.

Urban Area Fringe: Wells at two of these sites could tap the lower portion of Zone C, and wells at all three sites would tap Zones D and E.

The closest and most recent Zone C water quality data pertinent to Urban area fringe sites are from East side wells 30S/11E-20B7 and 30S/11E-17P4. Total dissolved solids (TDS) measured 210 milligrams per liter (mg/l) and 300 mg/l in 2005, respectively. Nitrate concentrations measured 8.8 mg/l as NO_3 at well 20B7 and 33 mg/l NO_3 at well 17P4 in 2005. Based on this information, nitrate concentrations in Zone C, where tapped by the hypothetical new wells, should be below drinking water standards.

The most recent lower aquifer water quality information for the East side includes information from the LOCSD South Bay site and the GSWC South Bay #1 site (a blend of upper and lower aquifers). TDS in monitoring wells 30S/11E-17E8 (Zone D) and 17E7 (Zone E) at the LOCSD South Bay site were last reported at 290 mg/l for Zone D and 440 mg/l for Zone E in 2005. Nitrate concentrations in at the LOSCD South Bay lower aquifer wells measured 9.3 m/gl as NO_3 (Zone D) and non-detect for Zone E. At the GSWC South Bay #1 site (Zone C, D , and E blend), TDS concentration was last reported at 370 mg/l in 2006, and nitrate was last reported at 2.2 mg/l as NO_3 in 2008.

Creek Valley: Any wells providing water for community supply in the creek valley would be expected to tap the lower aquifer zones D and E. Recent information is limited to analytical results for a sample of Zone E at well 30S/11E-20A, which reported a TDS concentration of 380 mg/l and a nitrate concentration of 2.9 mg/l in 2005. Historical information for several lower aquifer wells

in the creek valley is available, but the data is over 20 years old, and may not be representative of current conditions.

Conclusions

The SEAWAT model indicates that the sustainable basin yield under a VPA2b wastewater project scenario may be increased from 3,150 AFY to 3,400 AFY by developing wells on the East side near the creek valley boundaries, and up to 3,650 AFY by increasing creek valley well production. The additional yield comes primarily from increased capture of Los Osos Creek stream flow. Flow records for Los Osos Creek at Los Osos Valley Road indicate surplus water is available, but confirmation of adequate channel seepage capacity to support the maximum basin yield estimate has not been possible due to continued drought conditions.

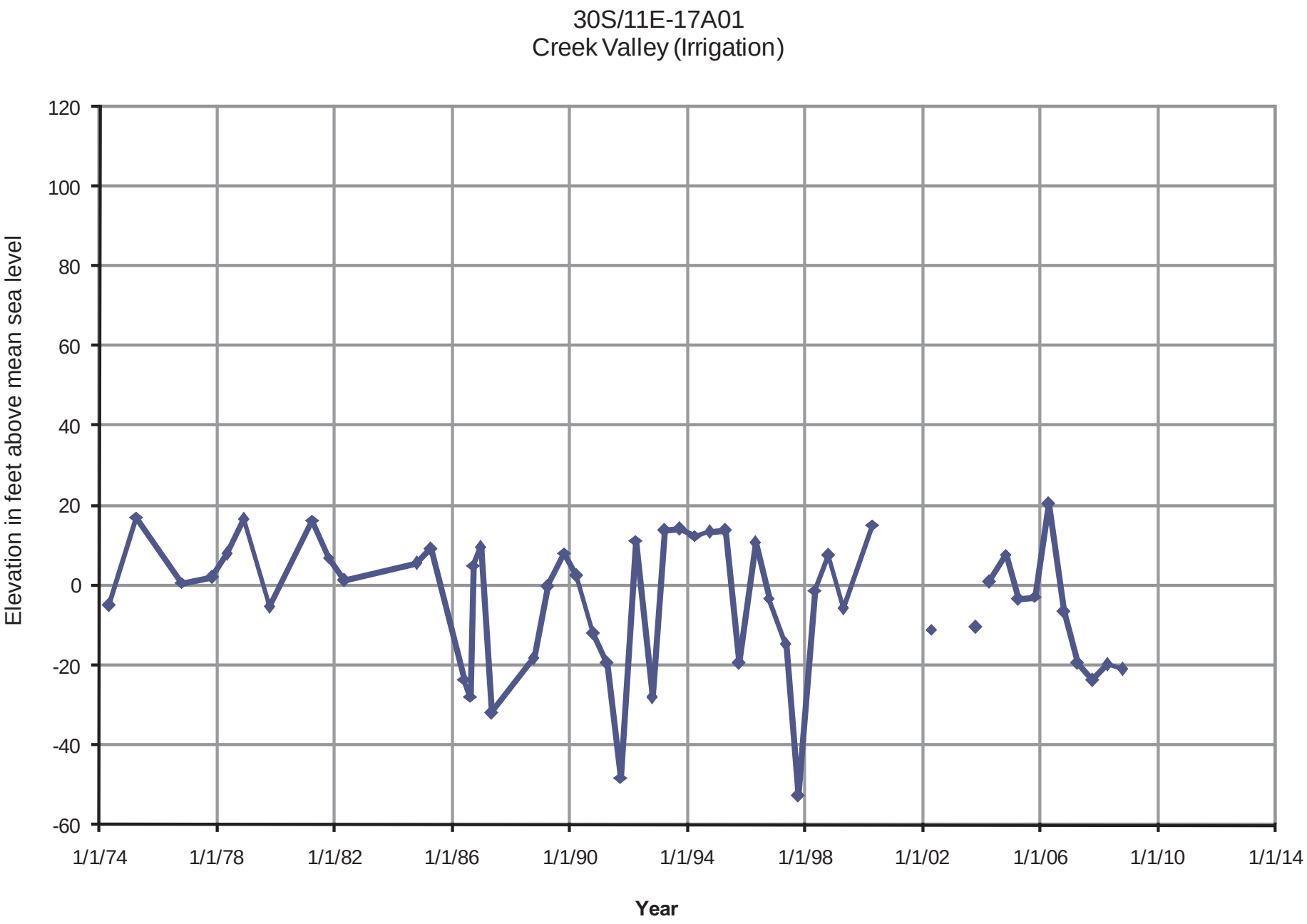
References

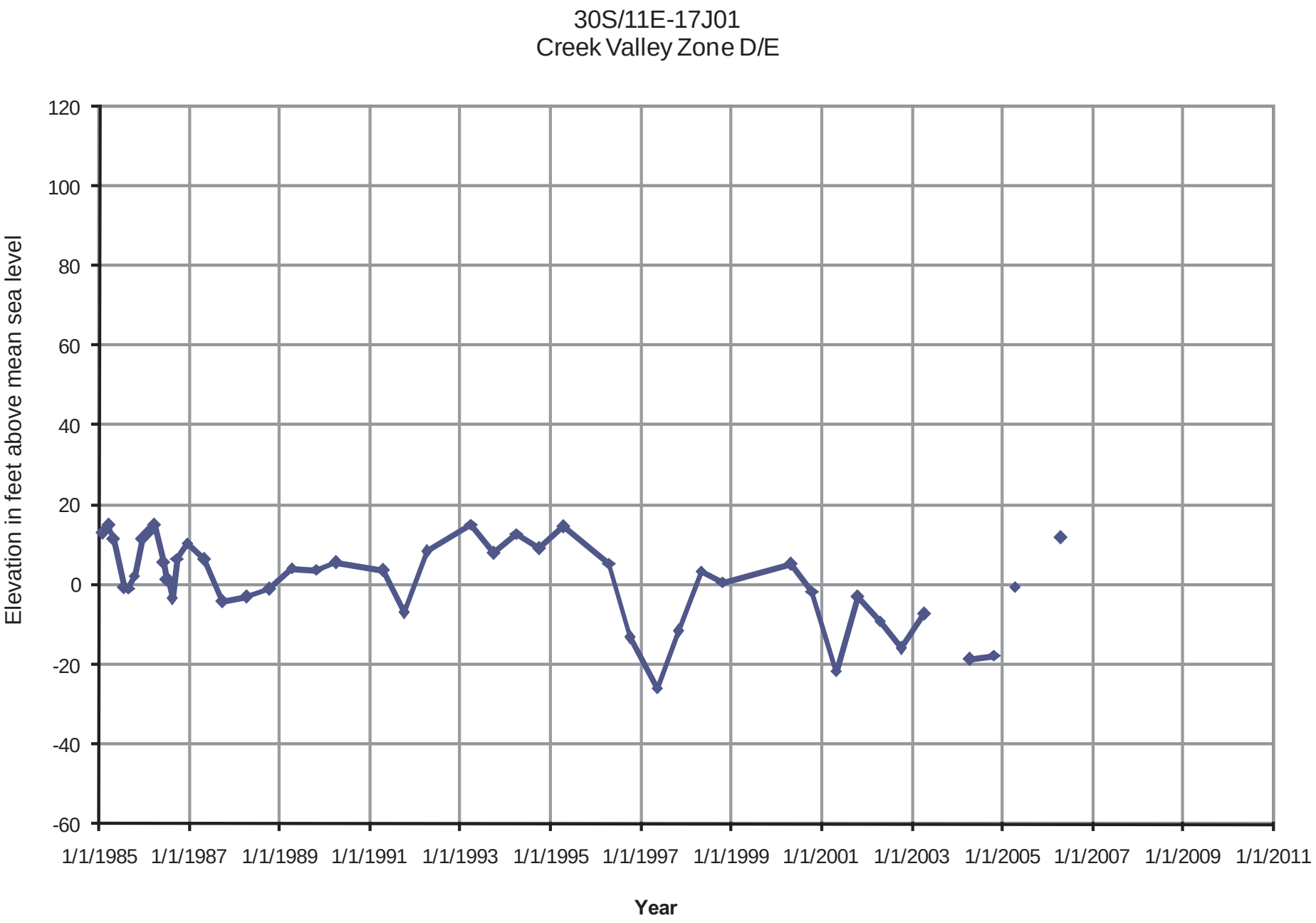
Cleath & Associates, 2008. Technical Memorandum to County Staff and LOWWP Consultants: Basin hydrologic budget with simulated groundwater elevation contour maps, August 7, 2008.

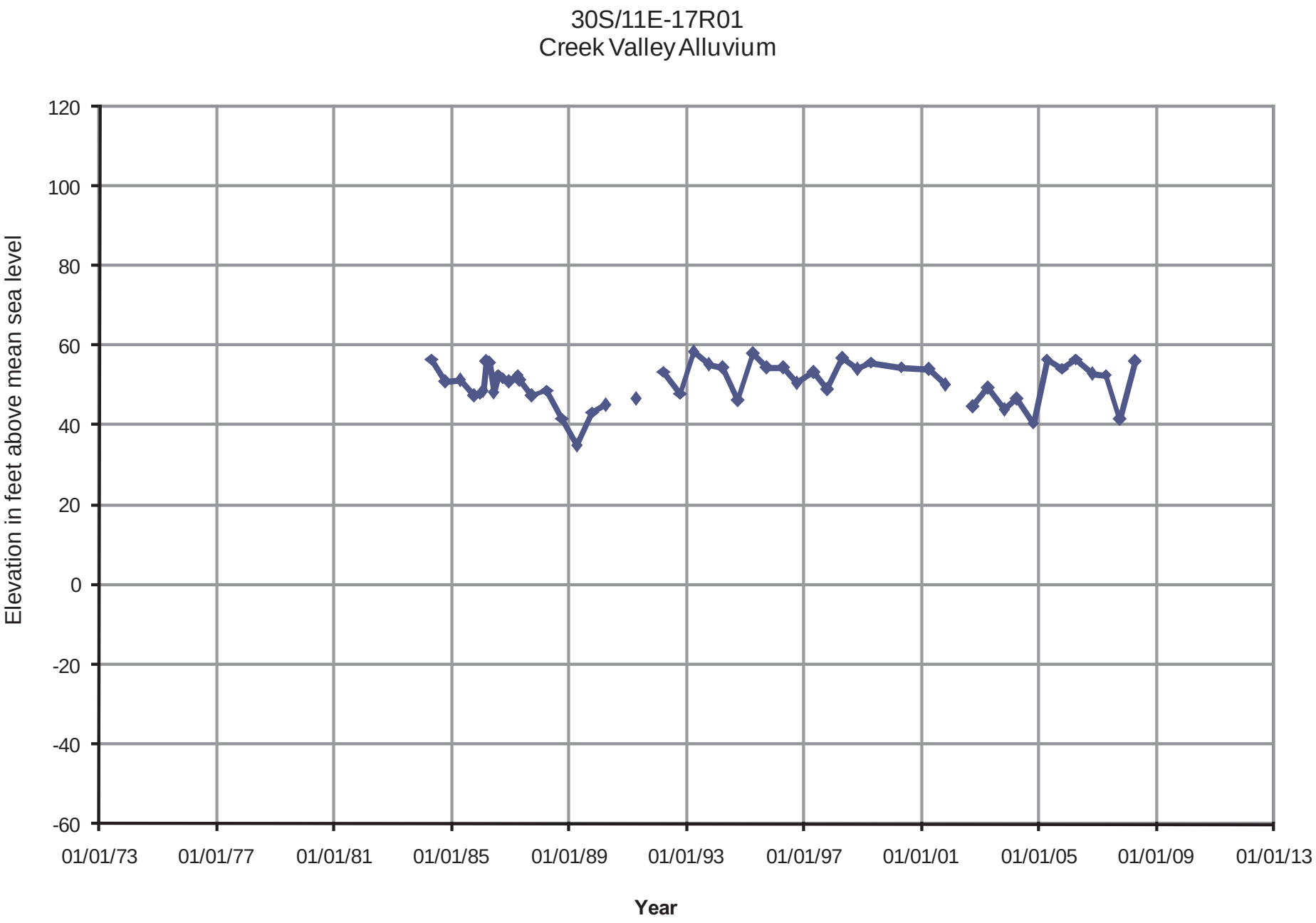
Morro Group, 1987. Appendix C of Final EIR for County Service Area No. 9, Wastewater Treatment Facilities - Los Osos, baywood Park, Cuesta-by-the-Sea, San Luis Obispo County, SCH# 84121914, dated August 1987.

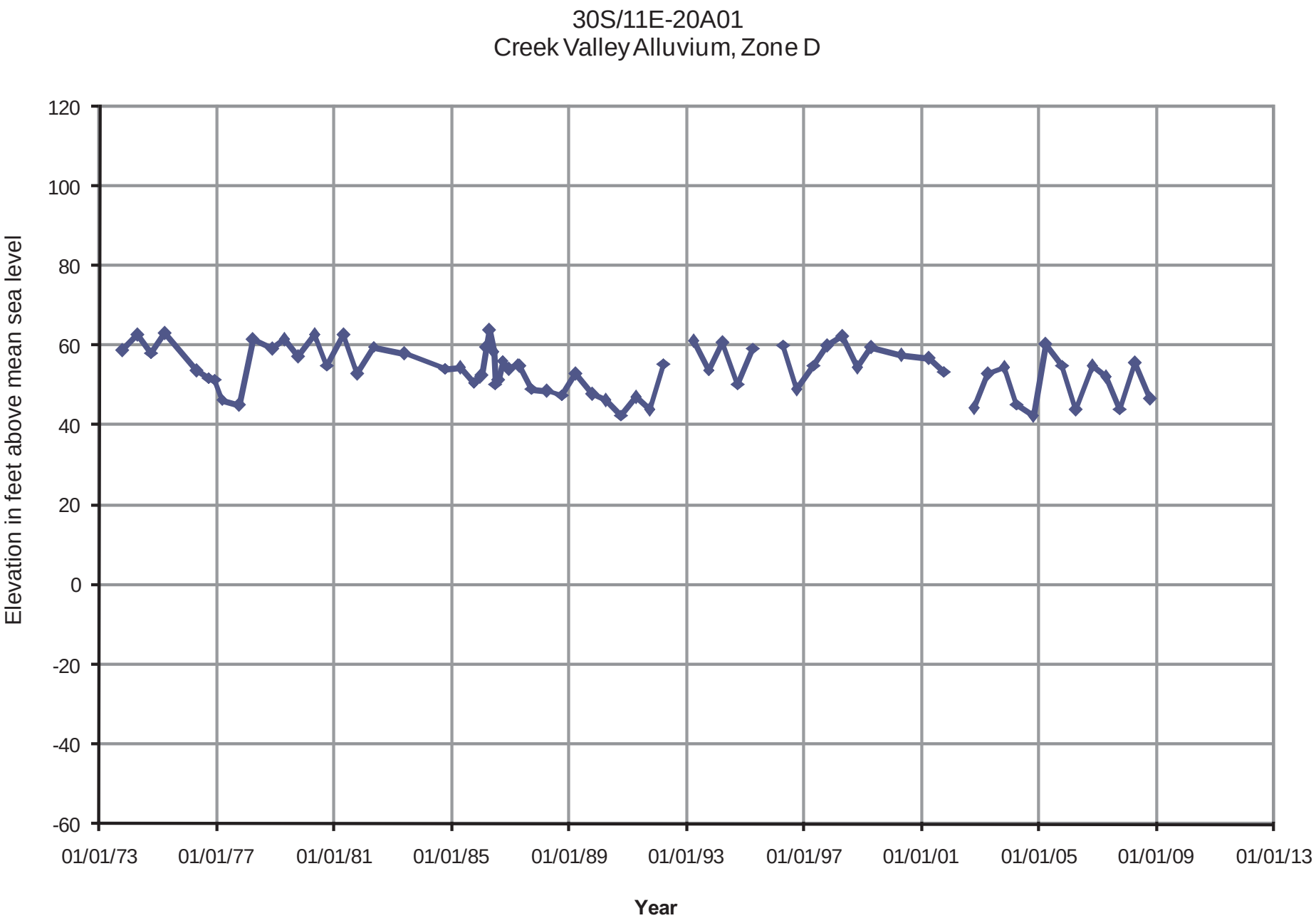
ATTACHMENTS:

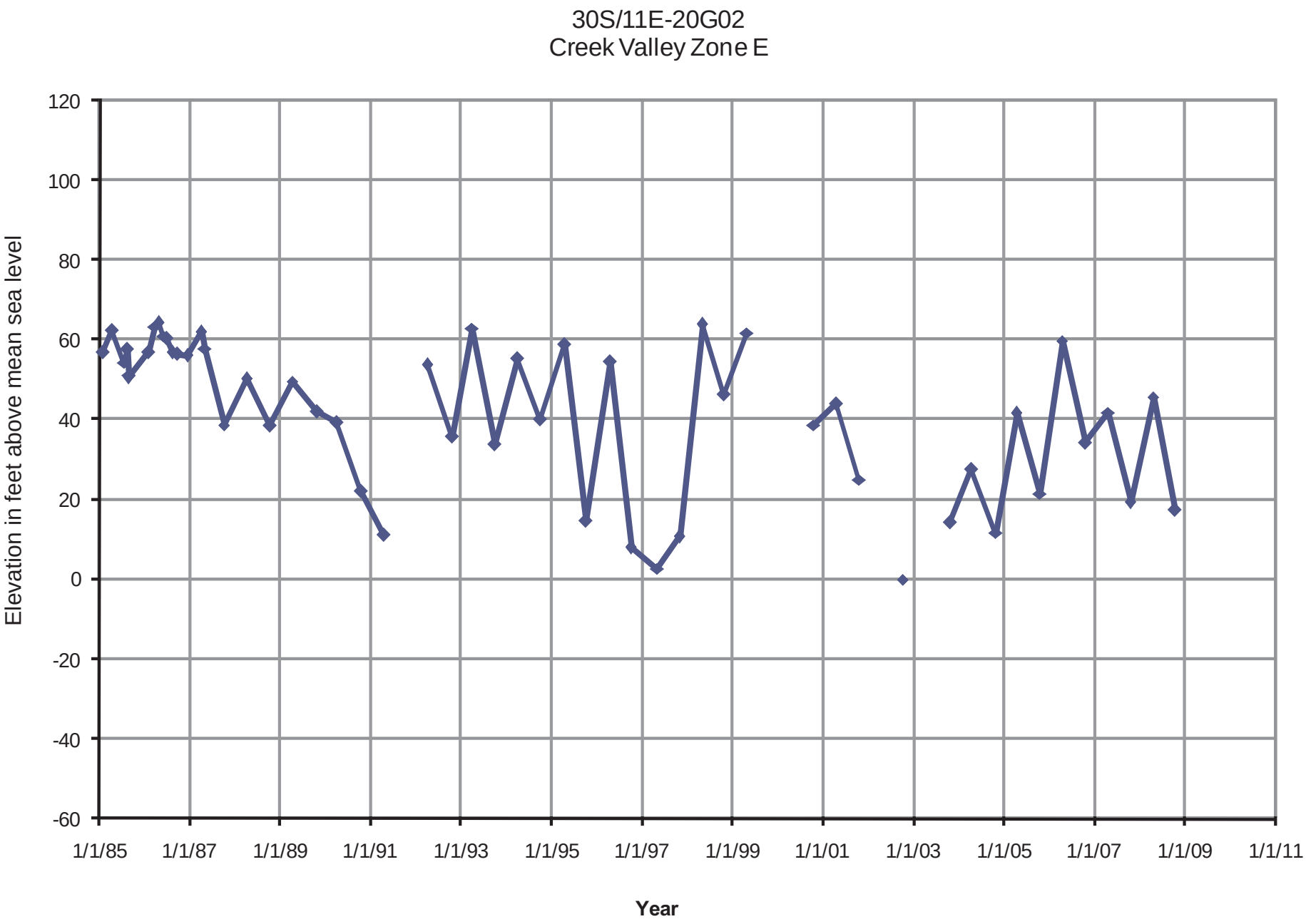
Water level hydrographs
Los Osos Creek stream flow data summary
Hydrologic budget diagrams

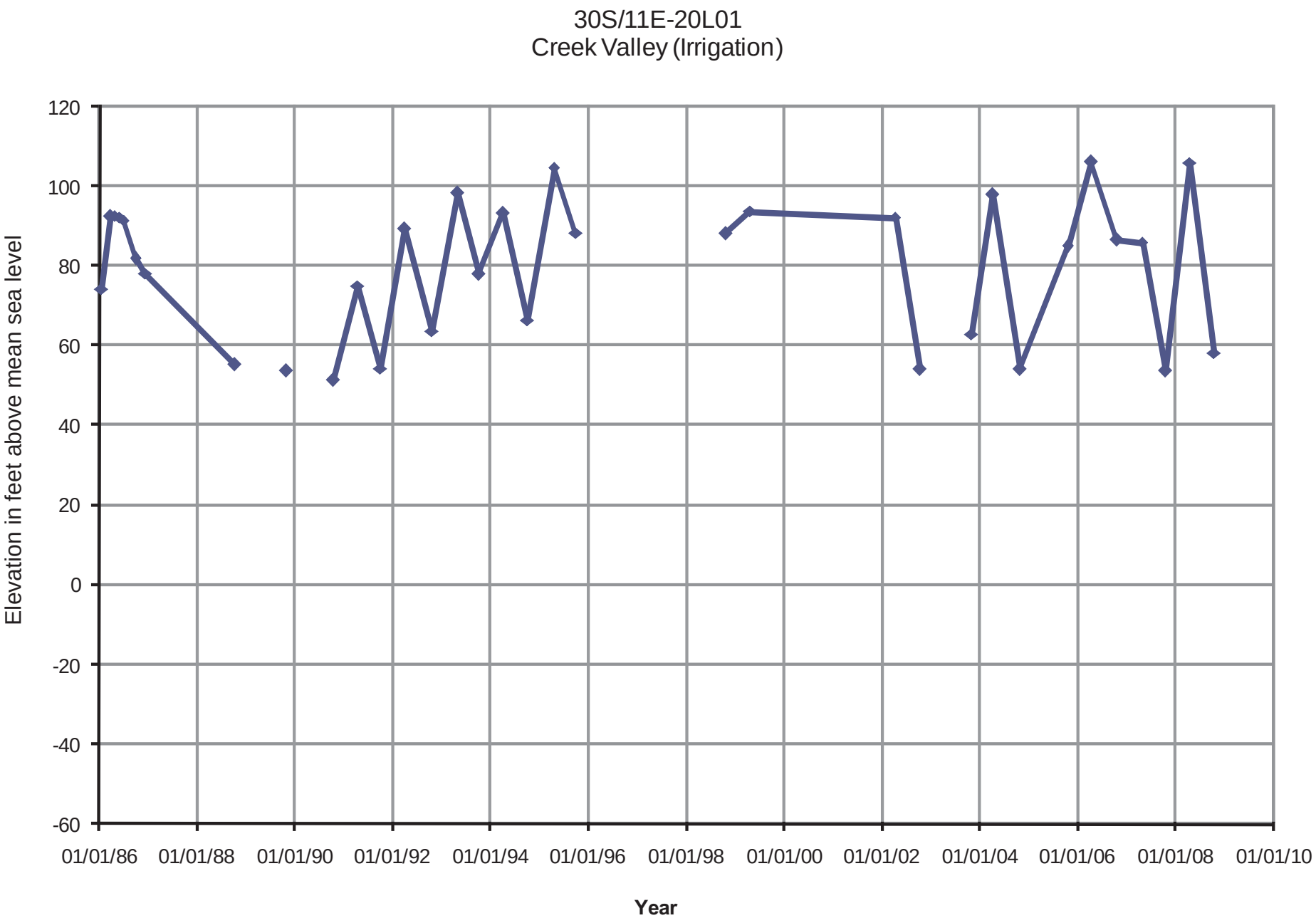

30S/11E-17A01
Creek Valley (Irrigation)
Elevation in feet above mean sea level
120
100
80
60
40
20
0
-20
-40
-60
1/1/74
1/1/78
1/1/82
1/1/86
1/1/90
1/1/94
1/1/98
1/1/02
1/1/06
1/1/10
1/1/14
Year

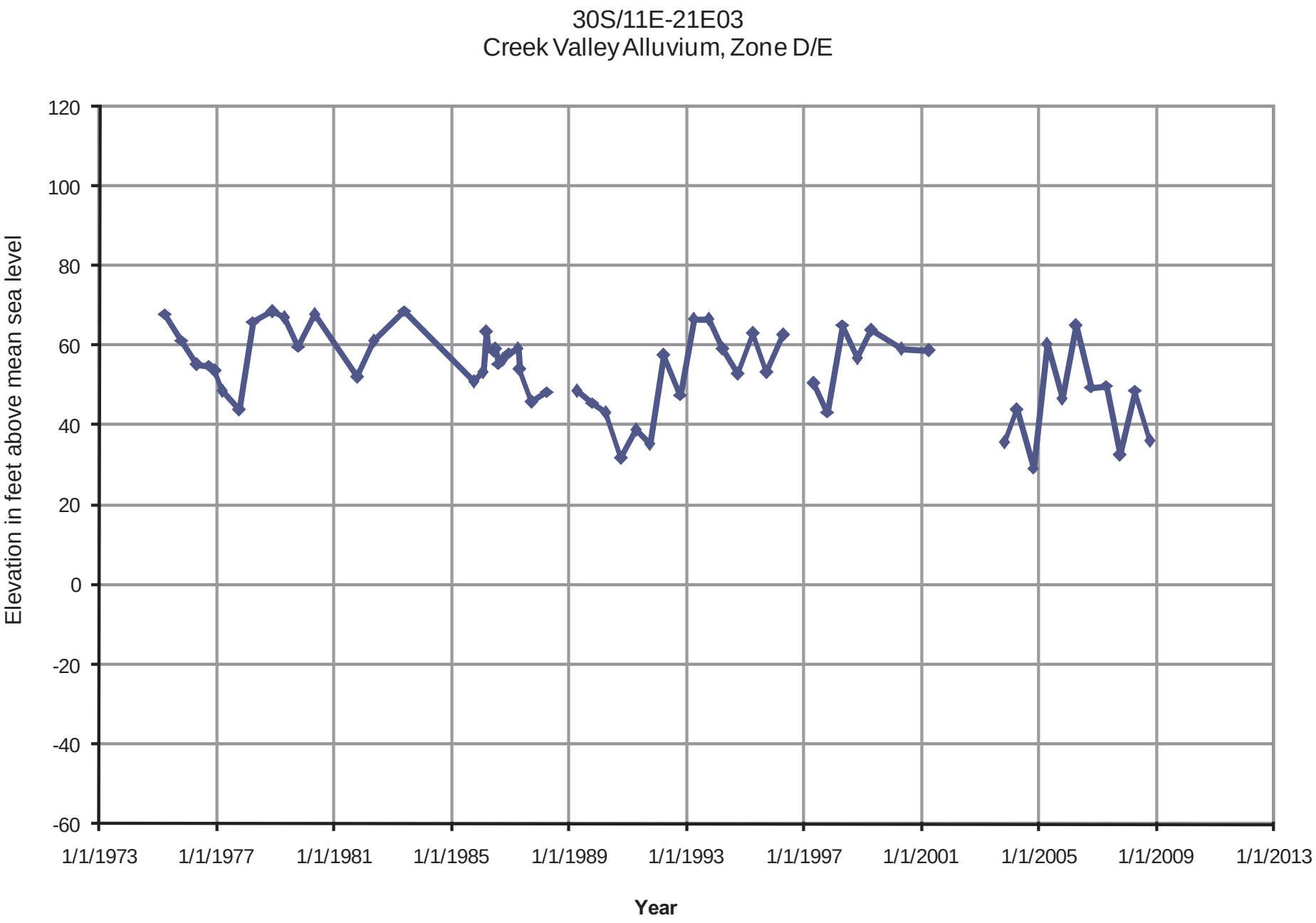

30S/11E-17J01
Creek Valley Zone D/E
Elevation in feet above mean sea level
120
100
80
60
40
20
0
-20
-40
-60
1/1/1985
1/1/1987
1/1/1989
1/1/1991
1/1/1993
1/1/1995
1/1/1997
1/1/1999
1/1/2001
1/1/2003
1/1/2005
1/1/2007
1/1/2009
1/1/2011
Year


30S/11E-17R01
Creek Valley Alluvium
Elevation in feet above mean sea level
120
100
80
60
40
20
0
-20
-40
-60
01/01/73
01/01/77
01/01/81
01/01/85
01/01/89
01/01/93
01/01/97
01/01/01
01/01/05
01/01/09
01/01/13
Year


30S/11E-20A01
Creek Valley Alluvium, Zone D
Elevation in feet above mean sea level
120
100
80
60
40
20
0
-20
-40
-60
01/01/73
01/01/77
01/01/81
01/01/85
01/01/89
01/01/93
01/01/97
01/01/01
01/01/05
01/01/09
01/01/13
Year


30S/11E-20G02
Creek Valley Zone E
Elevation in feet above mean sea level
120
100
80
60
40
20
0
-20
-40
-60
1/1/85
1/1/87
1/1/89
1/1/91
1/1/93
1/1/95
1/1/97
1/1/99
1/1/01
1/1/03
1/1/05
1/1/07
1/1/09
1/1/11
Year


30S/11E-20L01
Creek Valley (Irrigation)
Elevation in feet above mean sea level
120
100
80
60
40
20
0
-20
-40
-60
01/01/86
01/01/88
01/01/90
01/01/92
01/01/94
01/01/96
01/01/98
01/01/00
01/01/02
01/01/04
01/01/06
01/01/08
01/01/10
Year


30S/11E-21E03
Creek Valley Alluvium, Zone D/E
Elevation in feet above mean sea level
120
100
80
60
40
20
0
-20
-40
-60
1/1/1973
1/1/1977
1/1/1981
1/1/1985
1/1/1989
1/1/1993
1/1/1997
1/1/2001
1/1/2005
1/1/2009
1/1/2013
Year

Stream Flow

Stream Gage Name: **Los Osos Creek (#6)**
Water Planning Area: **3**

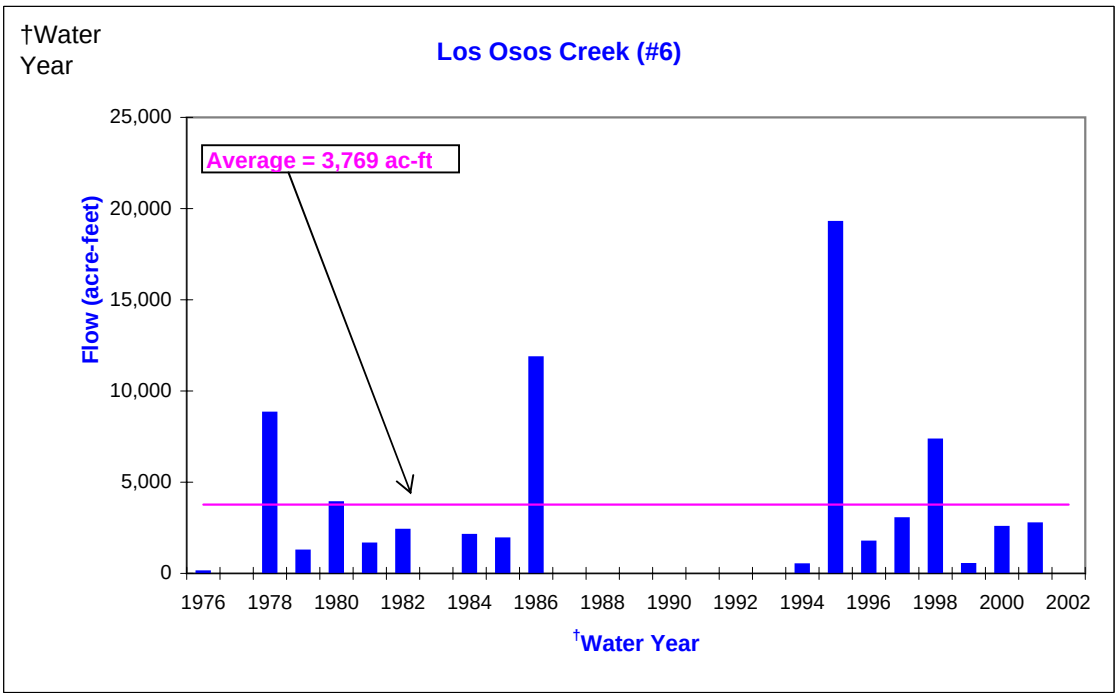
Water Year†	Annual Stream Flow (acre-feet)		Water Year†	Annual Stream Flow (acre-feet)	
1976	110	1	1990		9
1977	0		1991		10
1978	8,810		1992		11
1979	1,240		1993		12
1980	3,890	2	1994	497	
1981	1,630		1995	19,270	
1982	2,390	3	1996	1,740	
1983		4	1997	3,020	
1984	2,110		1998	7,340	
1985	1,920		1999	505	
1986	11,850	5	2000	2,540	
1987		6	2001	2,470	
1988		7	2002	0	
1989		8	2003	NA	13

From Annual Stream Flow Records	
Average Flow:	3,769 AFY
Median Flow:	2,110 AFY
Minimum Flow (2002):	0 AFY
Maximum Flow (1995):	19,270 AFY

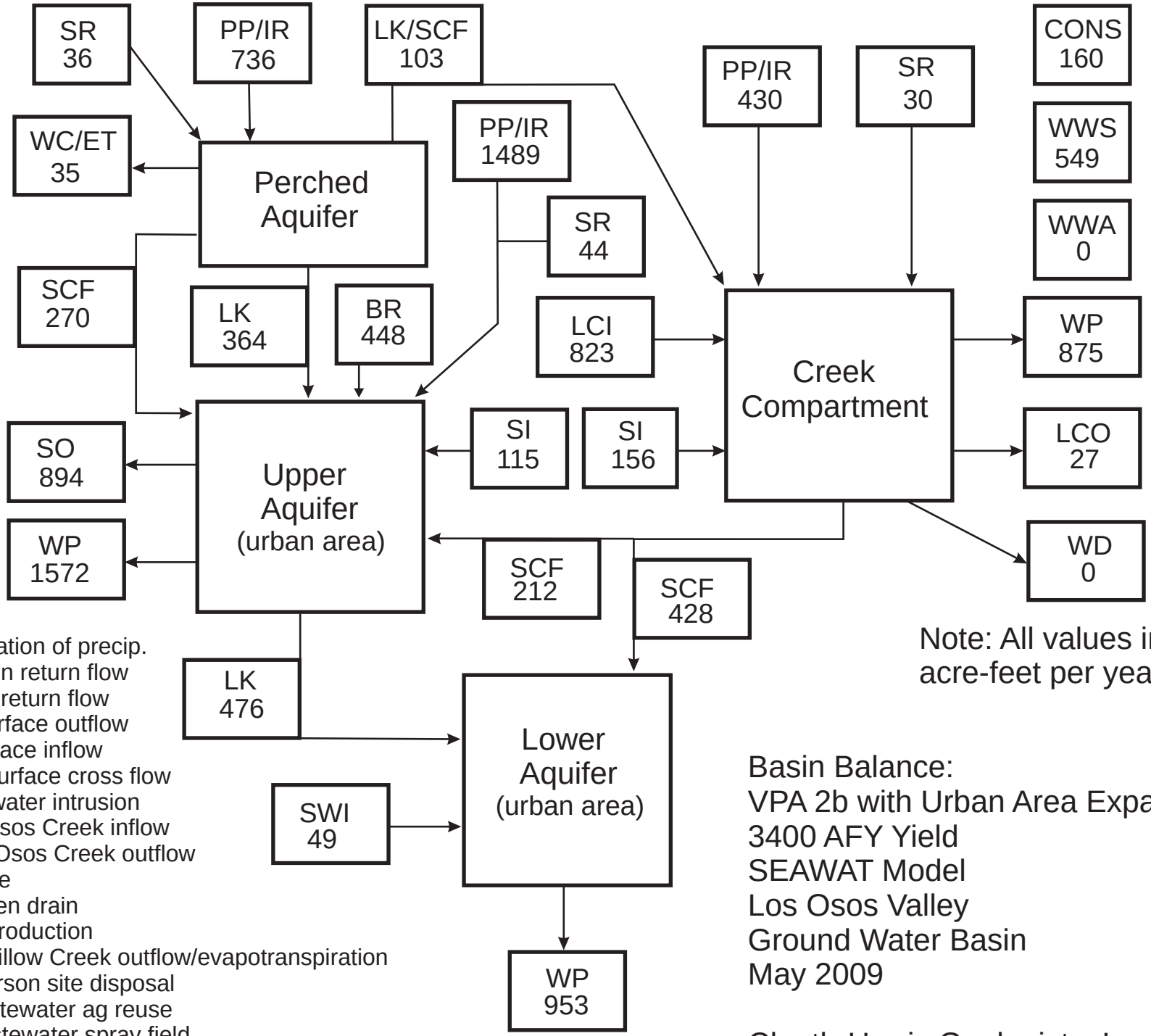
[1] gage put into operation in February
[2] missing data for one day in February
[3] missing data for various days in February, March, and April
[4] only visual observations were available for this year
[5] missing data for the end of February and beginning of March

[6-12] no data available for this time period
[13] Data not available at the time the report was published

(notations as recorded in San Luis Obispo County stream flow log books)



† October 1 - September 30



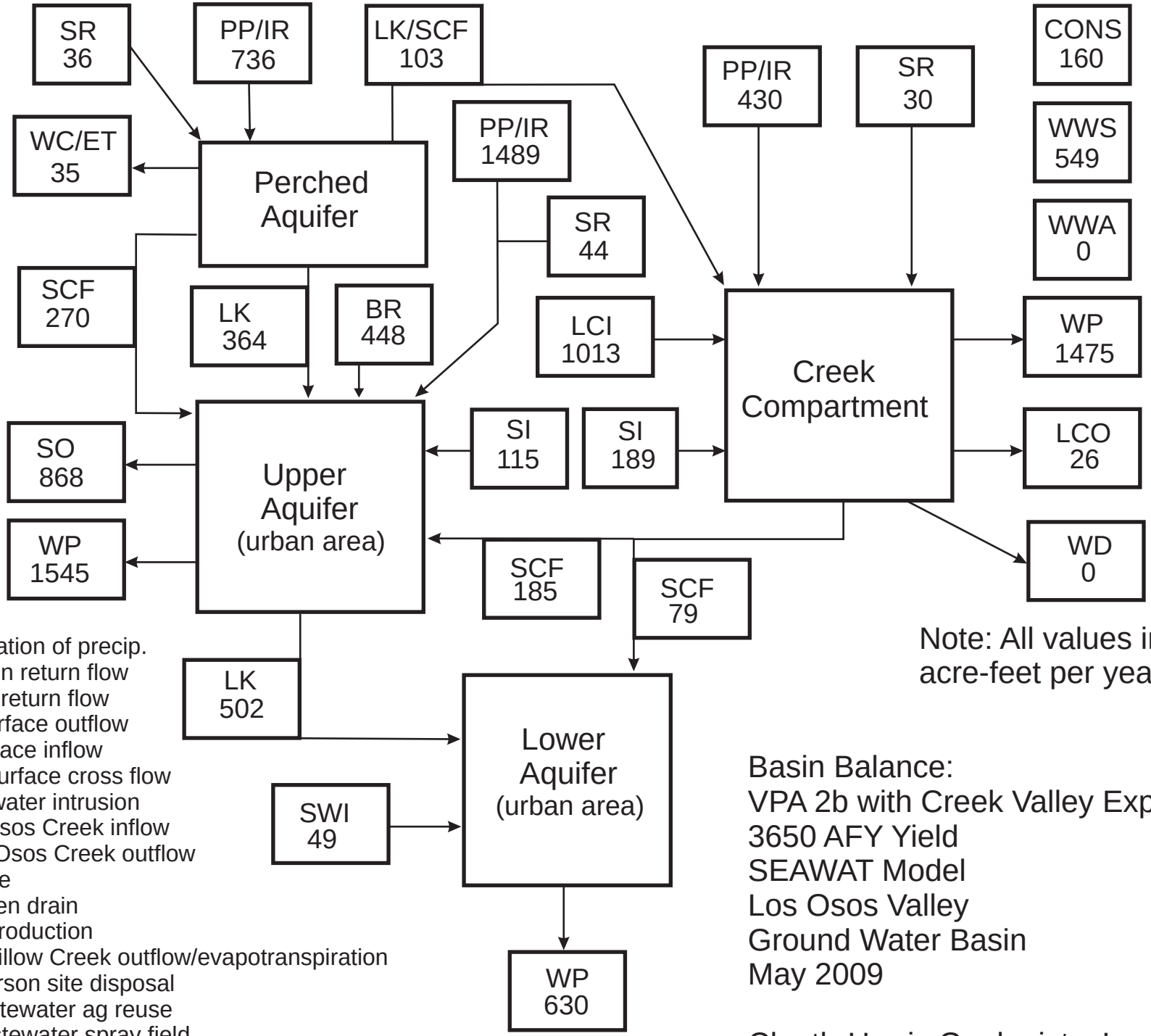
Legend

PP = percolation of precip.
IR = irrigation return flow
SR = septic return flow
SO = subsurface outflow
SI = subsurface inflow
SCF = subsurface cross flow
SWI = sea water intrusion
LCI = Los Osos Creek inflow
LCO = Los Osos Creek outflow
LK = leakage
WD = Warden drain
WP = well production
WC/ET = Willow Creek outflow/evapotranspiration
BR = Broderson site disposal
WWA = wastewater ag reuse
WWS = wastewater spray field
CONS = water conservation

Note: All values in acre-feet per year

Basin Balance:
VPA 2b with Urban Area Expansion
3400 AFY Yield
SEAWAT Model
Los Osos Valley
Ground Water Basin
May 2009

Cleath-Harris Geologists, Inc.



Legend

PP = percolation of precip.
IR = irrigation return flow
SR = septic return flow
SO = subsurface outflow
SI = subsurface inflow
SCF = subsurface cross flow
SWI = sea water intrusion
LCI = Los Osos Creek inflow
LCO = Los Osos Creek outflow
LK = leakage
WD = Warden drain
WP = well production
WC/ET = Willow Creek outflow/evapotranspiration
BR = Broderson site disposal
WWA = wastewater ag reuse
WWS = wastewater spray field
CONS = water conservation

Note: All values in acre-feet per year

Basin Balance:
VPA 2b with Creek Valley Expansion
3650 AFY Yield
SEAWAT Model
Los Osos Valley
Ground Water Basin
May 2009

Cleath-Harris Geologists, Inc.