Appendix K

Vineyard Water Availability Evaluation

Artesa Annapolis Vineyard
35147 Annapolis Road
Annapolis CA 95412

Prepared for:

Artesa Vineyards and Winery
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by

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Project Description

The property is located on a broad ridge crest south of Annapolis in northern Sonoma County. The proposed vineyards are situated on ridge tops and hillside slopes of 0 - 25% on a property that has been logged, pastured, and farmed in the past. The attached figures show the site, access, major water courses, and watershed limits as determined by other consultants and are adapted from the USGS 7.5-minute quadrangle map, Annapolis at 1" = 2000' and 40' contours.

Vineyard development activities will be completed in a work area limit of approximately 188 acres. Based on the companion vineyard development topography map, about 160 total vineyard acres and 129 acres of plantable vineyard are expected.

This report covers the vineyard water budget and the related collection and storage of surface runoff for irrigation purposes.

Site Hydrology

Estimates of surface runoff flow rates are necessary for vineyard water collection system evaluation. Surface runoff resources are substantial at this coastal ridgetop location, with total quantities used for design purposes dependent on baseline assumptions and source of data used for evaluation. The Sonoma County Water Agency isohyetal map is based on nearly 100 years of data and indicates an average annual rainfall of between 70 and 75 inches in the project area. Assuming 70" average rainfall and a 50% runoff factor results in an average watershed yield of about 2.9 acre feet per acre per anum (afa). If a more conservative 40% value is used, the per-acre yield is about 2.3 afa.

The Federal NOAA data for the same area covers a shorter, more recent time period at a substantially lower level of detail and estimates the average annual rainfall at about 58 inches. If the NOAA value is used, the yield is reduced to 2.4 afa at 50% runoff and 1.9 afa at 40% runoff. Under either assumption, 100% rainfall capture will occur within the sump and reservoir impoundments.

Figure 1 shows the long-term cumulative precipitation curve expected at Annapolis. Figure 2 shows the probability of annual precipitation. Both figures are prorated from SCS data at Fort Ross, and adjusted to conform with the NOAA average 58" rainfall. The latter shows cumulative annual probability for a particular rainfall total. Of interest is that a very dry condition with probabilities of 20-30% still result in rainfall totals of 40-50" per year.

Actual rainfall on the specific ridge crest in question is a function of, slope, aspect, surrounding orographic features, vegetative cover, long-term and perhaps evolutionary regional climate factors, and similar factors not accounted for in the generalized regional maps. Both seasonal and peak runoff will be further influenced by soil type, antecedent moisture conditions, ground cover, vegetative cover, drainage facilities, erosion control facilities, storm frequency and intensity, and similar factors. Due to the numerous parameters and inherent parameter variability, exact runoff volume and rate values for a particular time period cannot be predicted with certainty.

Water Development

Conservative drainage design is developed by using the higher Sonoma County Water Agency average annual rainfall values as a basis for computation. Conservative watershed yield assessment is developed by using the lower NOAA values for computation. Drainage design is covered in the companion Erosion Control Plan. This report is focused on watershed yield assessment within the upland vineyard drainage system. Diffuse sheet flow and swale flow will be intercepted and conveyed by pipe to a proposed sump and reservoir system in Block 2.

Vineyard development feasibility is dependent on adequate quality and quantity of water. Irrigation water will be required to establish vines, with possibly a reduced application rate in a premium wine program once the vines are well established. Frost protection irrigation is believed unnecessary at this high elevation ridge top location with good air drainage. The discussion that follows evaluates water collection variables at this site. Based on the evaluation, it appears that adequate water supplies can be developed to meet vineyard requirements.

Irrigation Demand: Annual water demands have been estimated per the table of Figure 3 and graph of Figure 4 based on the following assumptions. For 8' x 5' vine spacing, about 1090 vines per acre will be planted. Irrigation at 5.8 gal/vine/week over a 17 week irrigation season extending from June 1 to mid-October results in a maximum annual demand of about 100 gal/vine and 1/3 acre feet per planted acre per year. The estimated plantable area is about 129 acres. For irrigation demand purposes, we have arbitrarily increased that value by about 24% to 160 acres to provide some flexibility in planting density and to account for potential variation in acreage due to use of fewer or narrower avenues or similar adjustments within developed field areas. Assuming 160 plantable acres in the total project area results in an annual irrigation water demand of about 53 acre feet.

Evaporation Demand: The vineyard reservoir will be subject to seepage and evaporative losses during the storage season. Seepage will be eliminated by use of a lined reservoir. Evaporative losses were estimated as follows: The California Irrigation Management System collects Total Evapotranspiration (ETo) data from a standard grass sod lysimeter at a number of stations throughout California in important irrigation districts, as an aid in scheduling and management of water resources. The north Sonoma County coastal area is not a major irrigation district, so the closest and most appropriate stations with such data are in Petaluma, Santa Rosa, and the Oakland Foothills. The former two are in warmer interior valleys and the latter is subject to marine influence but is farther south and believed warmer than the Annapolis site. Average daily summer maximum temperatures are closely associated with ETo. They are not available for Annapolis, but at Ft. Ross near Annapolis they are about 15°F cooler than Santa Rosa per USDA-SCS data attached in Figure 5. Figure 6 shows the averaged bell curve ETo values for the three stations for the 1999-2003 growing seasons, which have average annual totals of 45, 45, and 40 inches per year.

The Oakland station is believed more representative of the marine influence at Annapolis than the closer interior valleys, so the 40" annual demand was used for evaluation. The lysimeter data adjustment for open water is about +10% of demand. Since Annapolis is not as sheltered and believed cooler than all stations, the + open water and - temperature adjustments between sites are reasonably assumed to cancel and a 40" annual evaporative demand used for project assessment. Assuming 40" evaporation at the +- 73 ac-ft reservoir mid-pool surface area results in a 12.7 ac-ft or 17% evaporation allowance.

Seepage Demand: Properly constructed earthen reservoirs in good soil conditions are subject to negligible to moderate amounts of seepage loss due to vertical migration of water into the soil profile. Seepage is difficult to quantify, as it cannot be measured directly, and is masked by both evaporation and other storage drawdown demands. For this project, the reservoir and sump will be treated with a synthetic liner to minimize risk of seepage losses. No seepage is expected to occur, and this consideration may be eliminated from the water budget.

Total Demand: Based on the comments provided above, the design irrigation demand is about 53 acre feet, the evaporation demand about 12.7 acre feet, and the seepage demand negligible. The capacity required to meet annual design needs is therefore about 66 acre feet. The reservoir design has a capacity of about 73 acre feet, providing about 11% reserve for annual operating demand. If the irrigation demand multiplier previously discussed is eliminated, the reserve capacity is increased to about 40%.

Water Sources: Potential water sources to meet viticultural demands include ground water, seasonal surface runoff water, and riparian withdrawal from local streams. Riparian use is not feasible at this site due to environmental stewardship considerations. Groundwater springs may or may not be available for development on site, but typically are seasonal in nature and of inadequate total capacity, and have therefore been discounted in this evaluation. Local residents have also expressed concerns relative to potential for impairment and/or depletion of ground water resources in the general Annapolis area due to incremental residential and agricultural developments over time. Groundwater sources including springs and wells will therefore not be used for vineyard irrigation and frost protection purposes.

System Configuration: A surface water collection and storage system has been designed for the vineyard. The system collects diffuse upland sheet flow from Units 2 and 6 with a total tributary area of about 36 acres. Runoff is delivered to a 2 acre-foot sump pond and pumped to an upland off-channel 73 acre-foot reservoir for seasonal storage. The reservoir will be recharged by a combination of captured sheet flow and direct precipitation on an annual basis.

Required Tributary Area: Annual capture of 73 acre feet can be achieved under a variety of rainfall and runoff conditions as follows: The lined reservoir and sump surface areas total 5.6 acres, with 100% rainfall capture at any annual rainfall total. Figure 7 shows required tributary area as a function of average rainfall between 35 and 80 inches/year and as a function of surface runoff factor between 30% and 60% of total precipitation. Under average years, about half the NOAA-based average of 58"/year is assumed to run off. The available 36.8-acre tributary area (see Figure 1 of the Erosion Control Plan) line is noted on the graph. The results indicate that for any combination of rainfall and runoff in excess of 47" and 35-40% runoff that sufficient water is available under 100% capture conditions to completely recharge the reservoir from an empty condition. A rainfall total of 47" or less has about a 27% chance of occurring on an annual basis, and would be considered a very dry year. Figure 8 shows a similar projection for demand-only recharge of 66 acre feet. As expected, the required rainfall amount at about 45" is less for a smaller total recharge volume.

Sump Pump Considerations: Upland sheet flow from about 36.8 acres is collected via a passive system of low slope vee ditches and piped drainages and conveyed via gravity to the 2 acre-foot sump. The sump is equipped with a float-actuated pump system to route the collected water to the off-channel 73 ac-ft upland storage impoundment. Runoff flows from individual storms in excess of the pump capacity and in excess of the buffering capacity of a part-full sump will therefore be discharged into the natural drainage system and will not be diverted to storage. (The discharge point is at an armored section of Class III channel with prominent bedrock outcrops, and has been factored into the project work area limits and Ordinary Water limits of a nationwide ACOE permit.) An assessment of runoff capture efficiency based on sump pump sizing is therefore necessary to determine system performance.

Rainfall Frequency and Intensity Estimation: Rainfall events are not uniform, occurring as light rain over an extended time period, and up to intense, short duration events. To assess sump and pump performance, it is necessary to first estimate a frequency of occurrence of storm events, and then estimate the relative contribution of such events to total runoff. Comparison of pump capacity to the spectrum of runoff events then allows estimation of a rainfall capture efficiency.

Rainfall intensity data for Annapolis was not readily available, so an analog was developed for evaluation purposes. The Erickson Ranch in Valley Ford CA is an observer for the Sonoma County Water Agency, and has unpublished daily rainfall records starting in 1949, covering a 58-year period. Valley Ford is about 40 miles south of Annapolis and is at lower elevation, but is about the same distance inland and exposed to the same broad Pacific-front type storms. The rainfall intensity and duration effects at the two locations would therefore be expected to be similar and proportional to the annual average totals.

The annual rainfall total at Annapolis estimated at 58" per NOAA is about 1.66 times that of Valley Ford with a measured 34.7" annual average. About 2030 daily Valley Ford rainfall records from 1950 – 1998 were evaluated in 2002 as part of this project, and were broken into ¼" increments from 0 – 2" daily rainfall, 1" increments from 2" – 4", and a final category of over 4". The distribution was prorated by the average annual rainfall multiplier to generate a similar distribution for Annapolis, with the increments enlarged by the 1.66 factor to 0.42" increments from 0-3.34"/day. Figure 9 illustrates the results and indicates that for Annapolis 24% of all rainfall events are expected to be less than 0.42"/day, 60% less than 1.25"/day, and 90% less than 2.9"/day. The remainder of the distribution would be from very infrequent large-scale storms that while dramatic, provide only a small fraction of the total watershed yield on a statistical basis.

Capture of Runoff Events and Runoff Volume: The available rainfall data is based on a 24-hour time period, which must be converted back to a rainfall event in order for meaningful evaluation of pump performance. For system evaluation purposes, we have assumed a conservative 6-hour storm event within the 24-hour time period in order to convert inches/day data to a storm-based flow rate from a particular watershed. The system evaluation also assumes rainfall events in any one year conform to the long term distribution of events inherent in the data used for evaluation.

A series of runoff capture efficiency curves is shown for pumps of 1, 2, 4, and 8 cfs capacity as a function of storm intensity (inches/hour) in a 36-acre watershed assuming 30% runoff (Figure 10) and 50% runoff (Figure 11) for average year conditions. Assuming the noted 6-hour storm duration allows re-projection of pump efficiency relative to daily rainfall rate, necessary for comparison with the rainfall distribution frequency data.

Figure 12 demonstrates that a 4 cfs pump can capture 100% of up to 1.25"/day rainfall runoff events, about 24+18.3+18.5 = 60.8% of the total. Rainfall events of 0.8" to 2.9"/day constitute 8.8+9.4+5.1+ 5.3 = 28.6% of the total event count and are captured at a declining rate of between 100% and 46%. Events under 2.9"/day total 89.3% of all rainfalls with a net capture of 78.9%. The combined rate and capture efficiency for more intense storms adds about 3.2% to the total for a +-82% event capture efficiency using a 4 cfs pump

Figure 13 demonstrates that a 4 cfs pump can capture 100% of up to1.25"/day rainfall runoff volume, about 6.1+9.4+14.2 = 29.8% of the total. Rainfall events of 1.67" to 2.9"/day constitute 9+12.1+7.8+9.4 = 68.1% of all volume and are captured at a declining rate of between 100% and 46%. Events under 2.9"/day total 68.1% of all volume with a net capture of 53.2%. The combined rate and capture efficiency for more intense storms adds about 8.8% to the total for a +-62% total volume capture efficiency using a 4 cfs pump.

Figure 14 allows comparison of rainfall events by daily totals to cumulative volume associated with such events on a percentage basis. A weighted average was used to assess relative contribution of individual rainfall events to total rainfall volume. For example, the first data point indicates that events less than 0.4" comprise about 24% of total events but yield only about 5% of the total volume. The variance between curves demonstrates that the larger, less frequent rainfall events have greater total contribution to total volume than do the more numerous smaller rainfall events. Figure 15 shows the same information in a different format showing cumulative volume as a function of daily rainfall totals.

Similar projections can be made for other pumping rates. Capture efficiency declines under wet-winter conditions when rainfall events are expected to be larger in magnitude and improves under the more critical dry year conditions when rainfall events tend to be at lower rates,

Minimum Rainfall Requirements for Reservoir Recharge Based on Volume Capture Efficiency: Prior to consideration of sump pump constraints on capture efficiency, it was shown that rainfall and runoff in excess of 47" and a 35-40% runoff factor from 36.8 acres would completely recharge the 73 acre-foot reservoir from an empty condition. For the estimated 6-hour rainfall events, average year conditions of 58" rainfall, and 50% runoff, a 4 cfs sump pump has the capacity to retain about 82% of the variably-sized runoff events, amounting to about 62% of the total rainfall volume.

Captured runoff amounts to 36.8 ac x (58/12) ft x .5 runoff x .62 capture = 55 ac-ft. Reservoir and sump capture amounts to 5.6 ac x (58/12) ft x 1.0 runoff x 1.0 capture = 27 ac-ft, for a total yield of 82 ac-ft. Complete reservoir recharge from dry conditions is therefore expected to occur under average-year rainfall using a 4 cfs pump at the sump. Complete recharge will also occur under wetter than average conditions, even though capture efficiency is reduced.

Reservoir Management: Figure 16 is output from a spreadsheet model incremented daily over a 365-day period, used to verify adequacy of the 73 acre-foot storage capacity relative to irrigation and ETo demands. Modeling necessarily uses assumed inputs that will vary from actual daily system performance, but remains valid as a method of evaluating design performance. Reservoir recharge will occur during the winter and spring sheet flow capture season. Design performance will be achieved when winter capture volume matches the combined 73 ac-ft summer-fall irrigation and evaporation volume.

The model parameters used limited collection to the December-April time period, in proportion to anticipated rainfall patterns. Evaporation was estimated using a 40" annual demand per the Oakland ETo curve as previously discussed and prorated over the residual reservoir surface area on a monthly basis. Irrigation demand was estimated per a normal vegetative growth curve in the June – October period with an assumed 160 acre vineyard requiring a total 53 acre-foot volume. The graph shows that pre-season evaporation may reduce storage volume below a brim-full 73 acre-feet at the onset of the irrigation season. Since the evaporative losses are already factored into the design, viticultural demand can be met throughout the season under such conditions.

The assessment has a built in safety factor of about 24%, since 160 acres was used for system sizing rather than the equivalent planted area of +-129 acres believed feasible at this time. Use of the higher value in the model results in a residual storage volume of about 8 acre feet at the end of the irrigation season.

Drought-Conditions Operation: The system is conservatively sized and will result in prior-year carry over under most operating conditions. Minimum replenishment required for complete irrigation and evaporation is 66 ac ft, which can be achieved with less than the average year rainfall.

Rainfall at less than the break-even performance criteria of 47" with 35-40% runoff has an estimated 20% to 40% probability of occurrence, depending on whether Sonoma County or NOAA values are used as the 50% probability value. Should drought conditions prevail, sub-optimal irrigation can be practiced that will still result in healthy vines and good productivity. For example, a minor 10% incremental reduction in the design application rate of 5.8 gal/vine/week (100 gal/vine/season) will reduce demand by 5.3 acre feet. During vineyard establishment, small vines do not normally require the full design application rate, providing reserve storage capacity under such conditions. Once vines are established, periodic deficit irrigation can be undertaken without significant detriment to the vineyard.

Summary

The vineyard erosion control and runoff management system located in off-channel upland areas provides the dual purpose of upland sheet flow collection for delivery to the off-channel irrigation reservoir. The system has been evaluated for adequacy in collecting and storing irrigation water, considering rainfall patterns, dry year conditions, and constraints imposed by the sump and pump system. Conservative design values have been used, providing a safety factor in evaluating system performance. Adequate water supplies are believed available to meet viticultural demands under the constraining normal to dry year conditions and under operating constraints imposed by use of a sump and pump collect runoff.

List of Figures

Figure 1

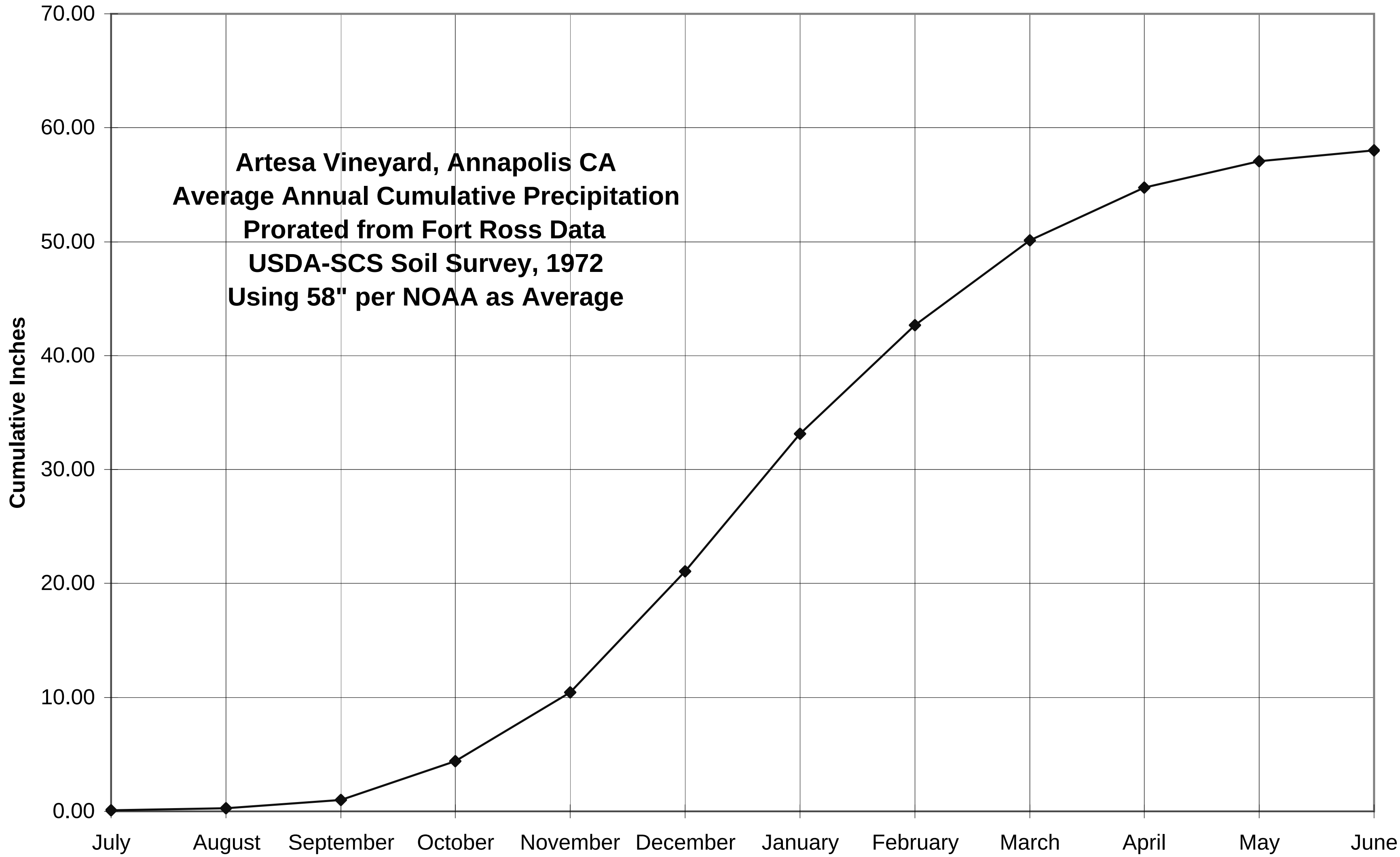
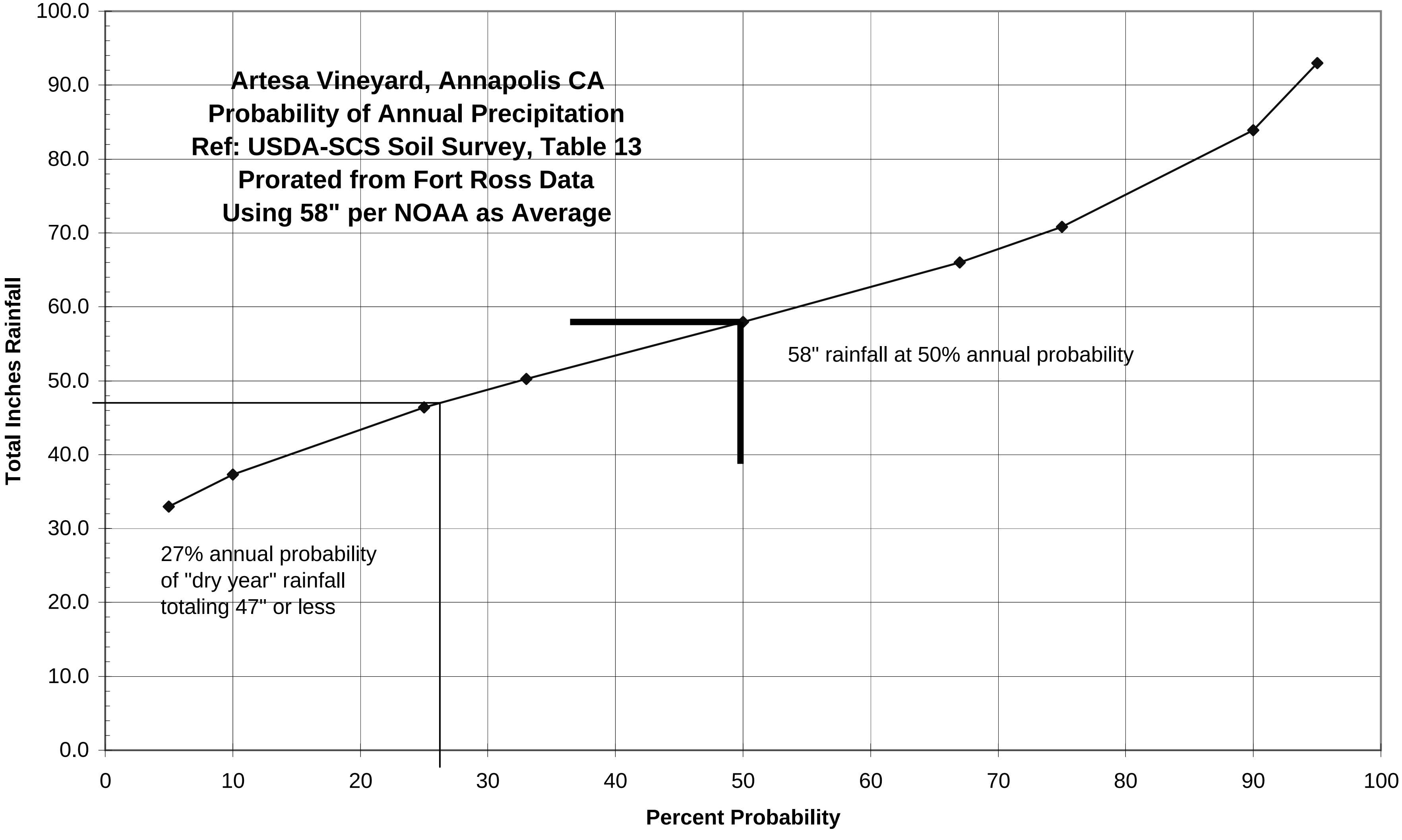

Artesa Vineyard, Annapolis CA
Average Annual Cumulative Precipitation
Prorated from Fort Ross Data
USDA-SCS Soil Survey, 1972
Using 58" per NOAA as Average
Cumulative Inches
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
July
August
September
October
November
December
January
February
March
April
May
June

Figure 2.


Artesa Vineyard, Annapolis CA
Probability of Annual Precipitation
Ref: USDA-SCS Soil Survey, Table 13
Prorated from Fort Ross Data
Using 58" per NOAA as Average
Total Inches Rainfall
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
58" rainfall at 50% annual probability
27% annual probability
of "dry year" rainfall
totaling 47" or less
0
10
20
30
40
50
60
70
80
90
100
Percent Probability

Irrigation and Frost Protection Storage Requirements

Erickson Engineering Inc, Valley Ford CA 94972-0446

Figure 3

Artesa Fairfax Vineyard		File:	70603 fairfax/fairfax
35147 Annapolis Road		Time:	05:05 PM
Annapolis CA 95412		Date:	24-Dec-09
		Updated:	04-Jun-07

Irrigation Data:			**Required Flow:**		
Vineyard area:	160.0	acres	5.81	gal/vine	100
Block Area:	10.0	acres/block	1089	gph/ac	gal/vine/yr
Rows:	8.00	ft wide	18.2	gpm/ac	
Vines:	5.00	ft apart	6331	gal/ac/set	
Vines/ac:	1089.0	vines	63314	gal/block/set	
Drip gph/vine:	1.00	gal/hr/vine	17.2	sets/season	
Irrigation set:	5.81	hours	1089000	gal/block/season	
Irrig frequency:	7.0	days between sets	16.0	blocks	
Irrig season:	17.2	weeks	17424000	Total gal/season	
Seep/Evap loss:	17.5	percent of stored	53.4	Acre Feet/season	
	66.2	Req'd Season Storage	0.334	acre-feet/acre/year	

Irrigation Output

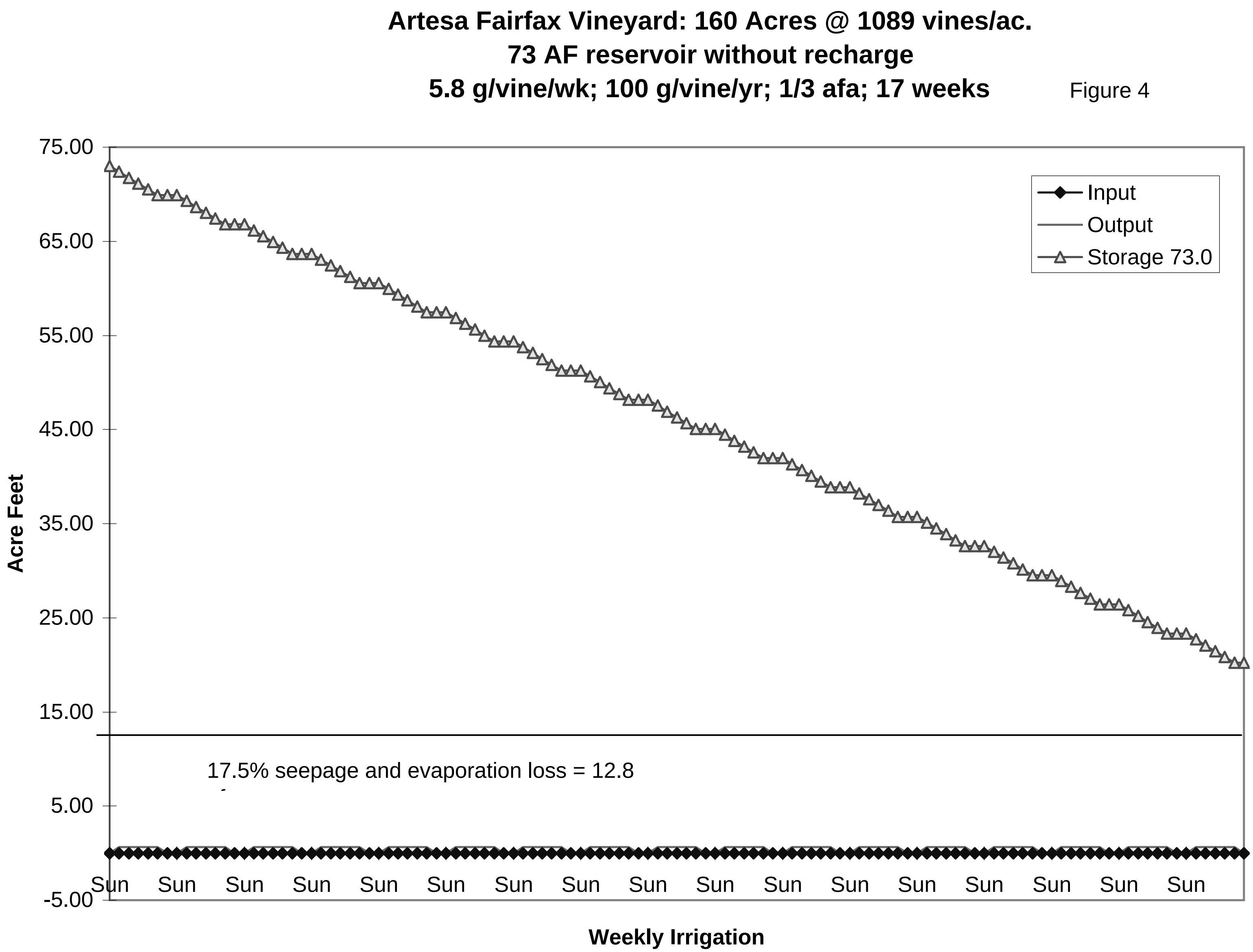
5.0	days/cycle (week)	(change daily data in chart table)	
3.20	blocks/day/cycle	182	gpm/block
202604.7	gal/day discharge	581	gpm, simultaneous blocks
0.62	ac-ft/day discharge	18.6	hours irrigation, sequential

Spring/Well Recharge:

Rate:	0.00	gal/min	0.00	ac-ft/day
Period:	24.0	hr/day	0.00	ac-ft/irrig period
Volume:	0	gal/day	0.00	ac-ft/mo

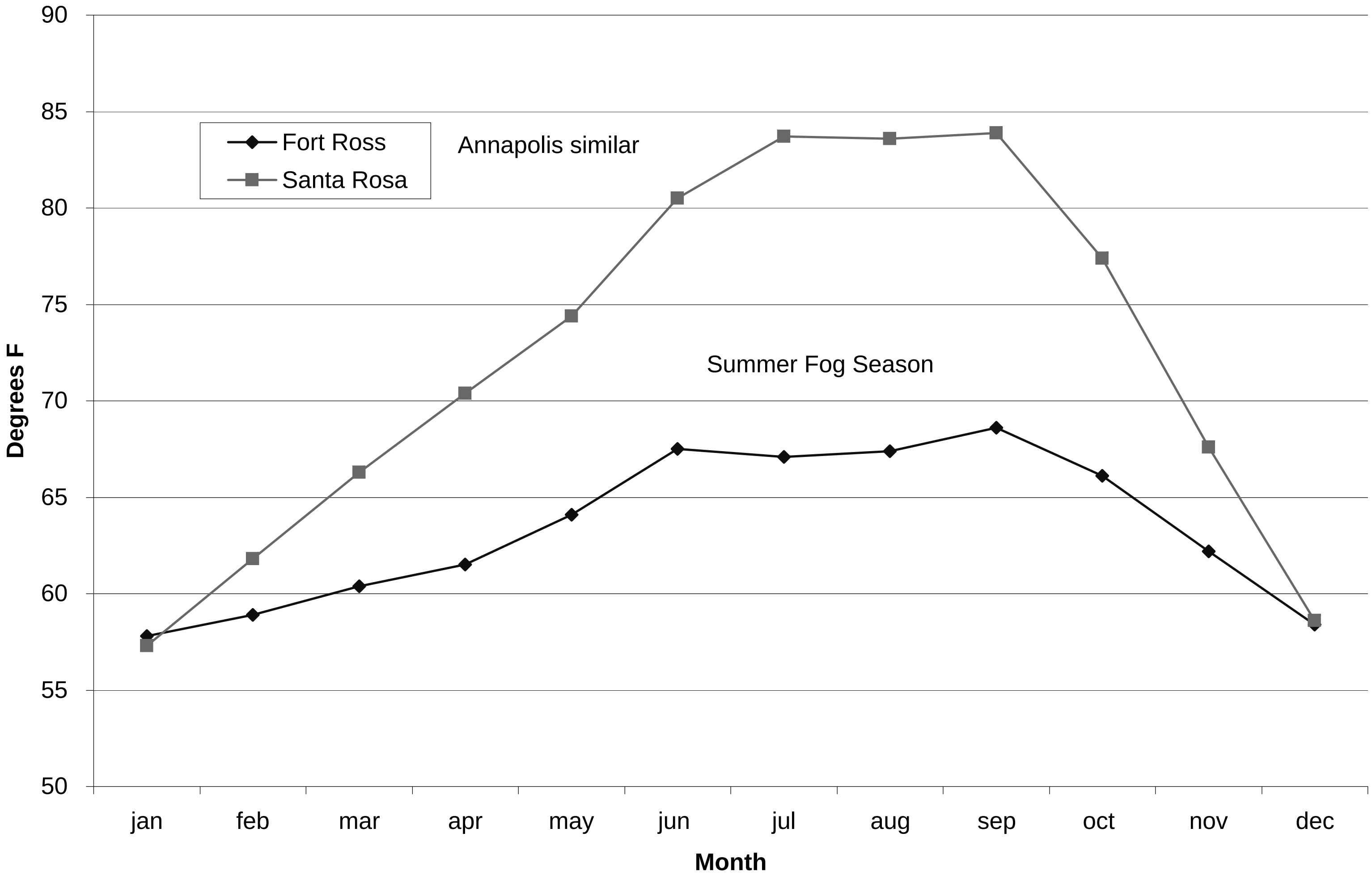
Frost Protection Data			**Required Flow:**	
Area:	0	acres	0.00	gpm
Sprinkler rate:	20	gal/min/ac	0.00	cfs
Set time:	6	hours	7200	gal/ac/night
Nights Required:	6	nights	0	gal/night
	1089	vines/ac	0.00	ac-ft/night

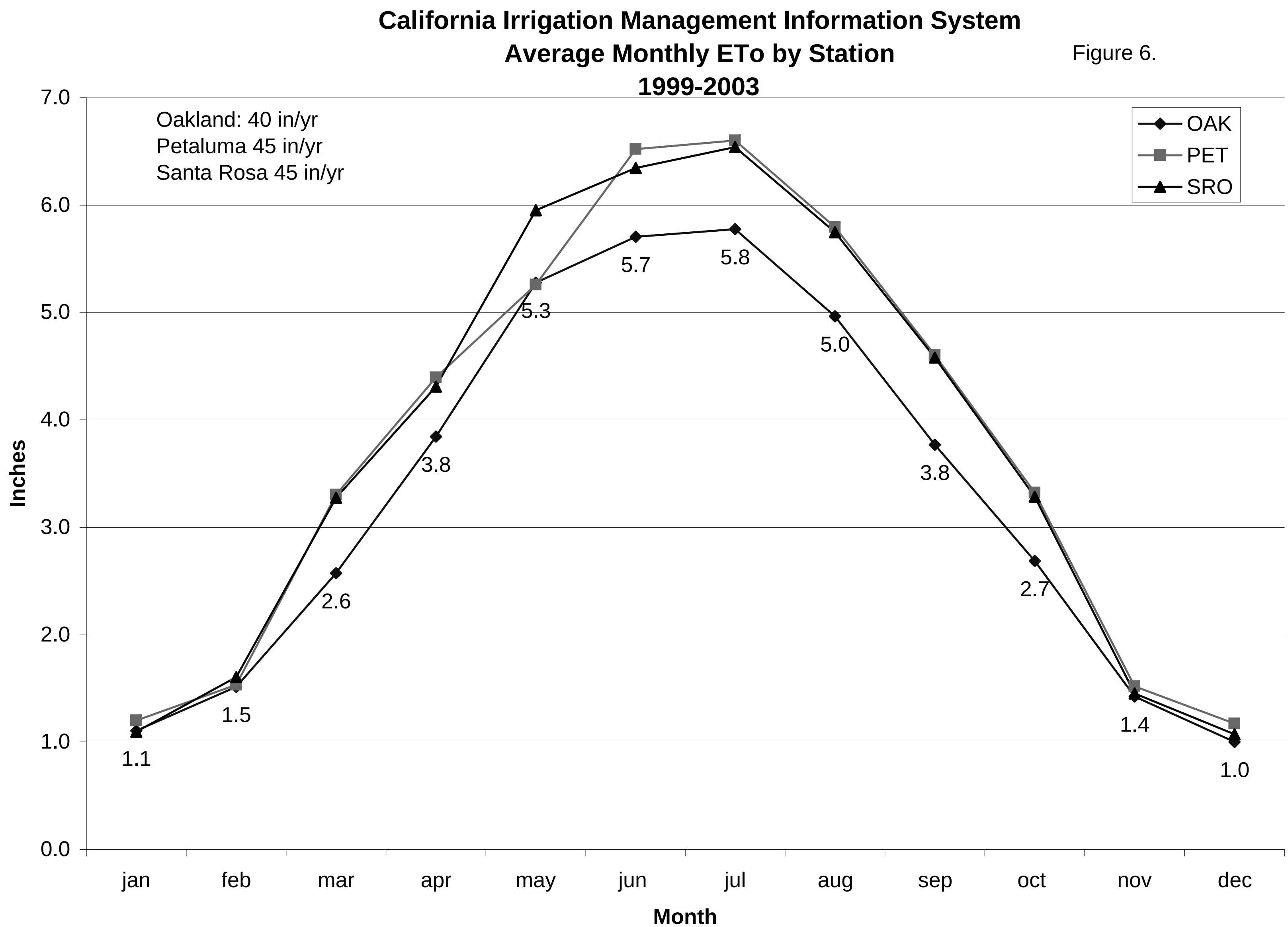
Spring/Well Recharge:			**Required Storage Volume:**		
Rate:	0.00	gal/min	0.00	ac-ft	Per acre per night
Period:	24	hr/day	0.00	ac-ft	Total per night
Volume:	0	gal/day	0.00	ac-ft	Season frost vol requir
	0.00	ac-ft/day	0.00	ac-ft	recharge reduction
	0.00	ac-ft/frost period	0.00	ac-ft	Req'd min useable sto
	0.00	ac-ft/mo			

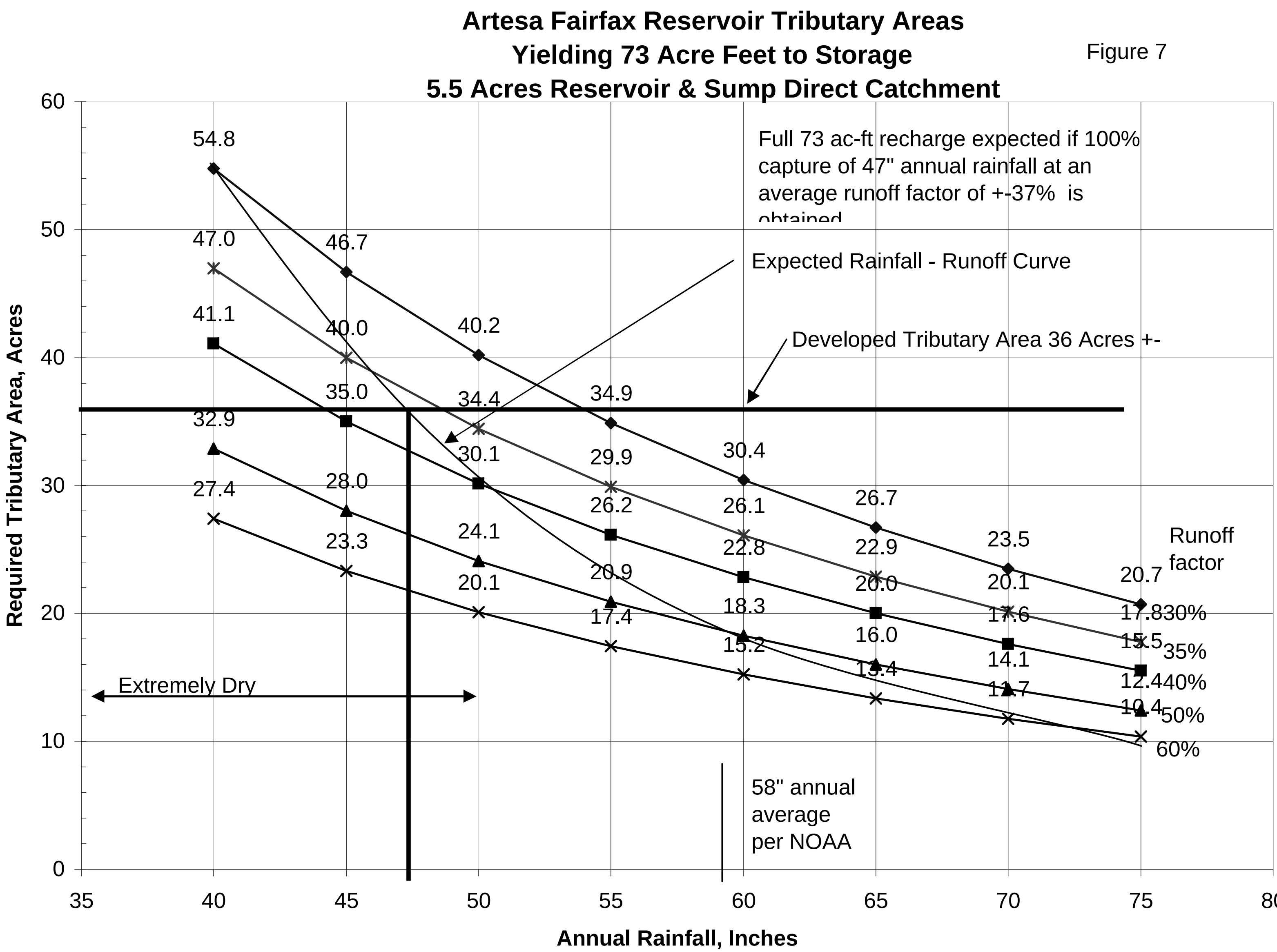

Artesa Fairfax Vineyard: 160 Acres @ 1089 vines/ac.
73 AF reservoir without recharge
5.8 g/vine/wk; 100 g/vine/yr; 1/3 afa; 17 weeks
Figure 4
75.00
65.00
55.00
45.00
35.00
25.00
15.00
5.00
-5.00
Acre Feet
Input
Output
Storage 73.0
17.5% seepage and evaporation loss = 12.8
Sun
Weekly Irrigation

USDA SCS Sonoma County Soil Survey
Table 11 (Portion) Average Max Temperature
Santa Rosa and Fort Ross

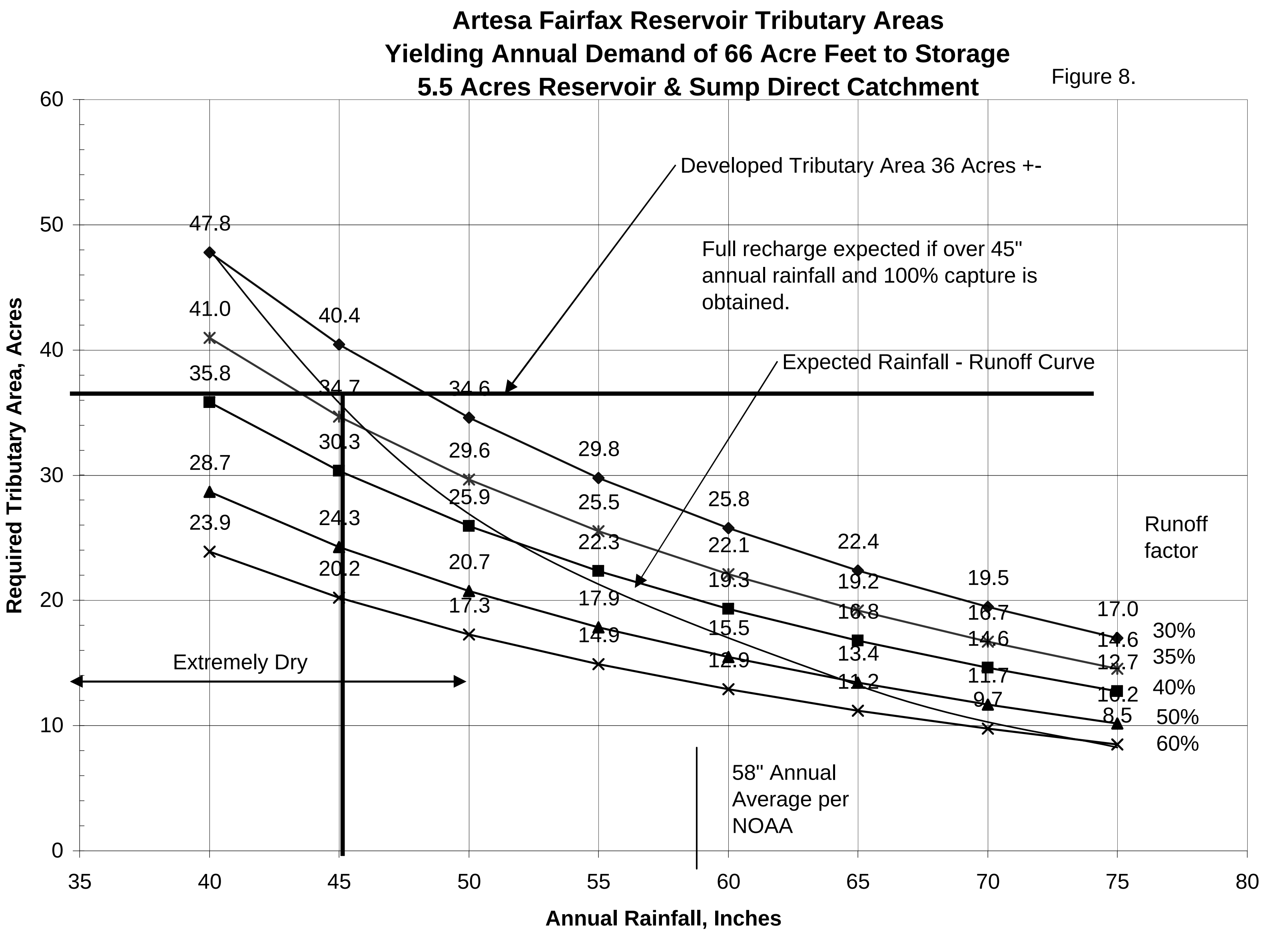
Figure 5.




California Irrigation Management Information System
Average Monthly ETo by Station
1999-2003
Figure 6.
Oakland: 40 in/yr
Petaluma 45 in/yr
Santa Rosa 45 in/yr
OAK
PET
SRO
Inches
Month
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
jan
feb
mar
apr
may
jun
jul
aug
sep
oct
nov
dec
1.1
1.5
2.6
3.8
5.3
5.7
5.8
5.0
3.8
2.7
1.4
1.0

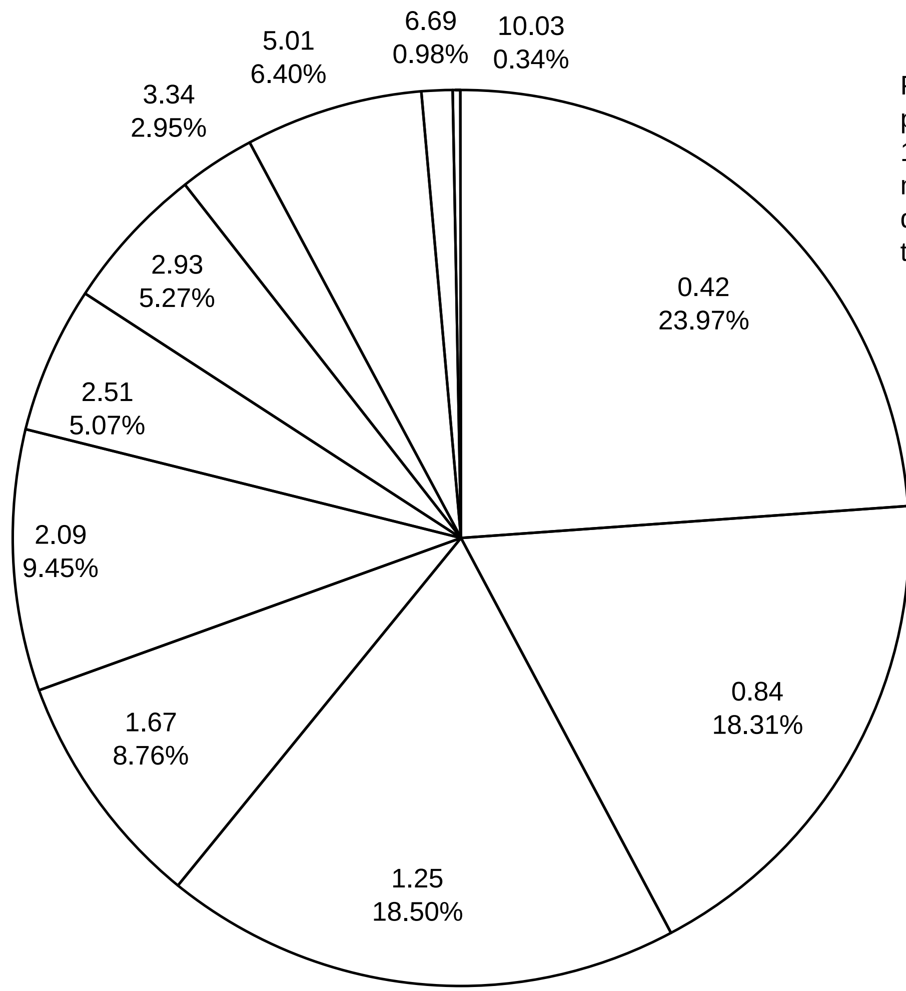


Artesa Fairfax Reservoir Tributary Areas
Yielding 73 Acre Feet to Storage
5.5 Acres Reservoir & Sump Direct Catchment
Figure 7
Full 73 ac-ft recharge expected if 100% capture of 47" annual rainfall at an average runoff factor of +-37% is obtained
Expected Rainfall - Runoff Curve
Developed Tributary Area 36 Acres +-
Runoff factor
30%
35%
40%
50%
60%
Extremely Dry
58" annual average per NOAA
Required Tributary Area, Acres
Annual Rainfall, Inches
54.8
46.7
40.2
34.9
30.4
26.7
23.5
20.7
47.0
40.0
34.4
29.9
26.1
22.9
20.1
17.8
41.1
35.0
30.1
26.2
22.8
20.0
17.6
15.5
32.9
28.0
24.1
20.9
18.3
16.0
14.1
12.4
27.4
23.3
20.1
17.4
15.2
13.4
11.7
10.4


Artesa Fairfax Reservoir Tributary Areas
Yielding Annual Demand of 66 Acre Feet to Storage
5.5 Acres Reservoir & Sump Direct Catchment
Figure 8.
Developed Tributary Area 36 Acres +-
Full recharge expected if over 45" annual rainfall and 100% capture is obtained.
Expected Rainfall - Runoff Curve
Extremely Dry
58" Annual Average per NOAA
Runoff factor
30%
35%
40%
50%
60%
Required Tributary Area, Acres
Annual Rainfall, Inches
47.8
40.4
34.6
29.8
25.8
22.4
19.5
17.0
41.0
34.7
29.6
25.5
22.1
19.2
16.7
14.6
35.8
30.3
25.9
22.3
19.3
16.8
14.6
12.7
28.7
24.3
20.7
17.9
15.5
13.4
11.7
10.2
23.9
20.2
17.3
14.9
12.9
11.2
9.7
8.5

Estimated Distribution of Daily Precip (inches/day)
Artesa Fairfax Vineyard, Annapolis CA

Figure 9



Prorated from 2030 data points at Valley Ford CA 1950-1998 via 1.66x multiplier to account for differences in annual rainfall totals.

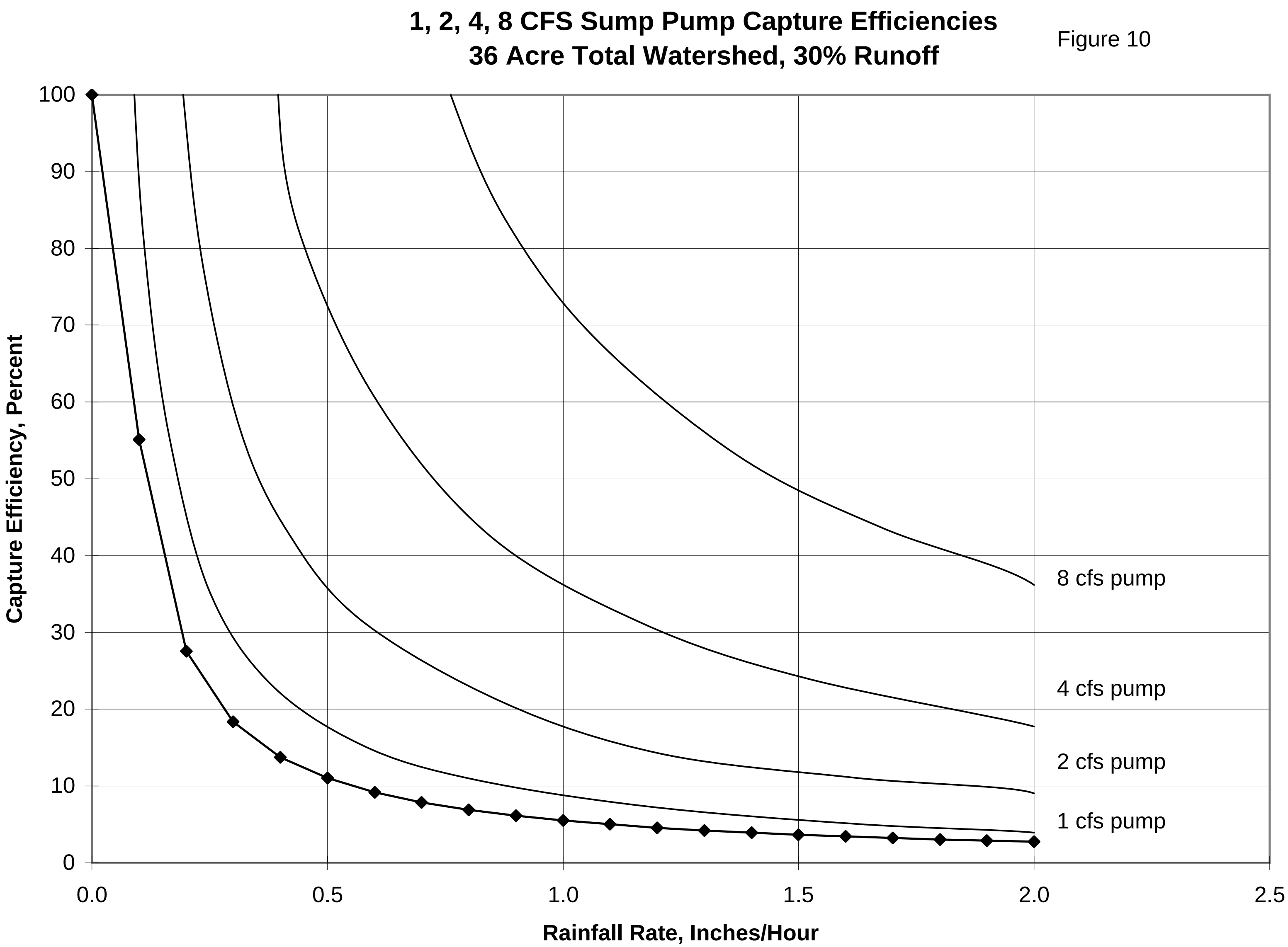
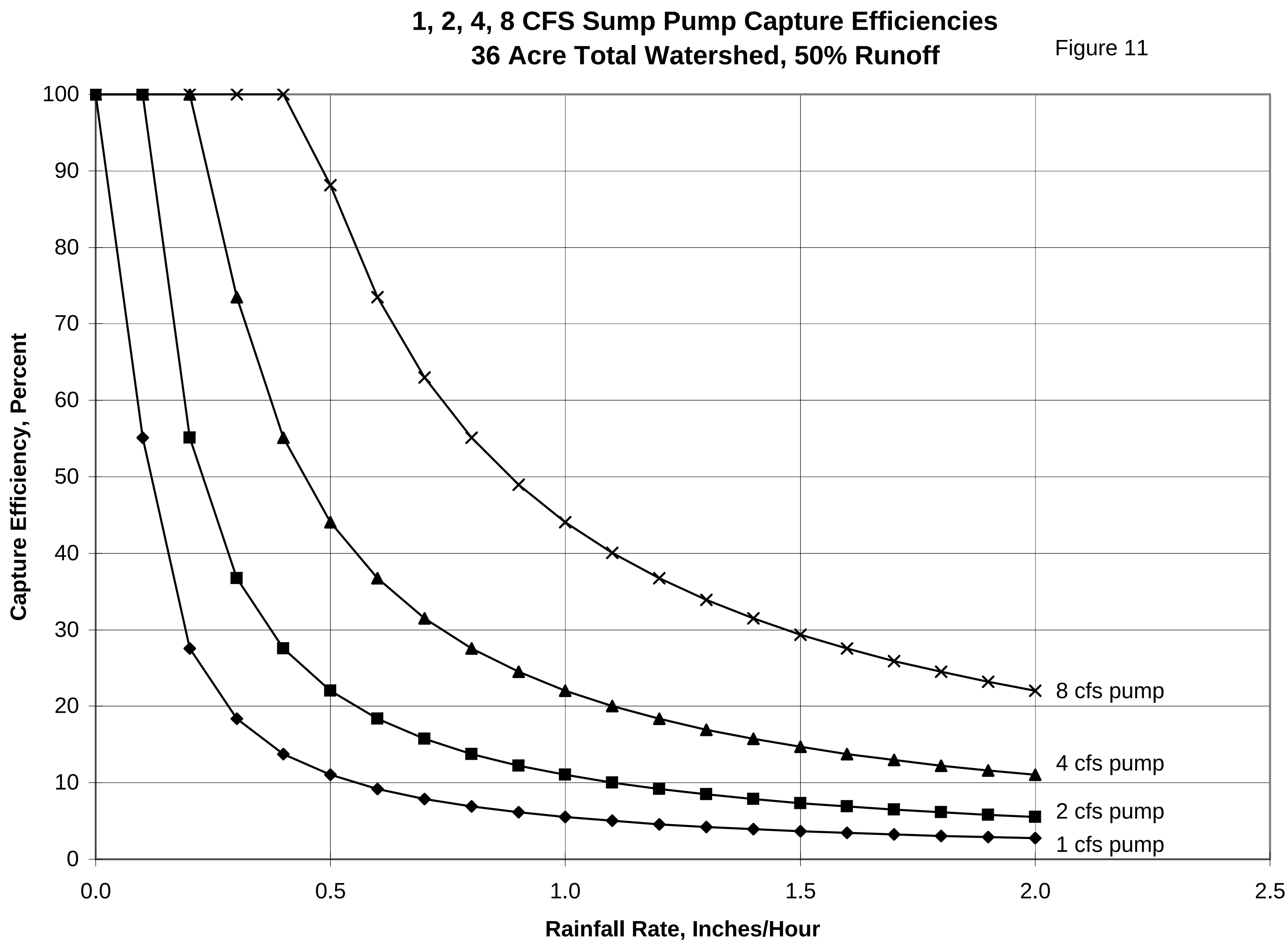
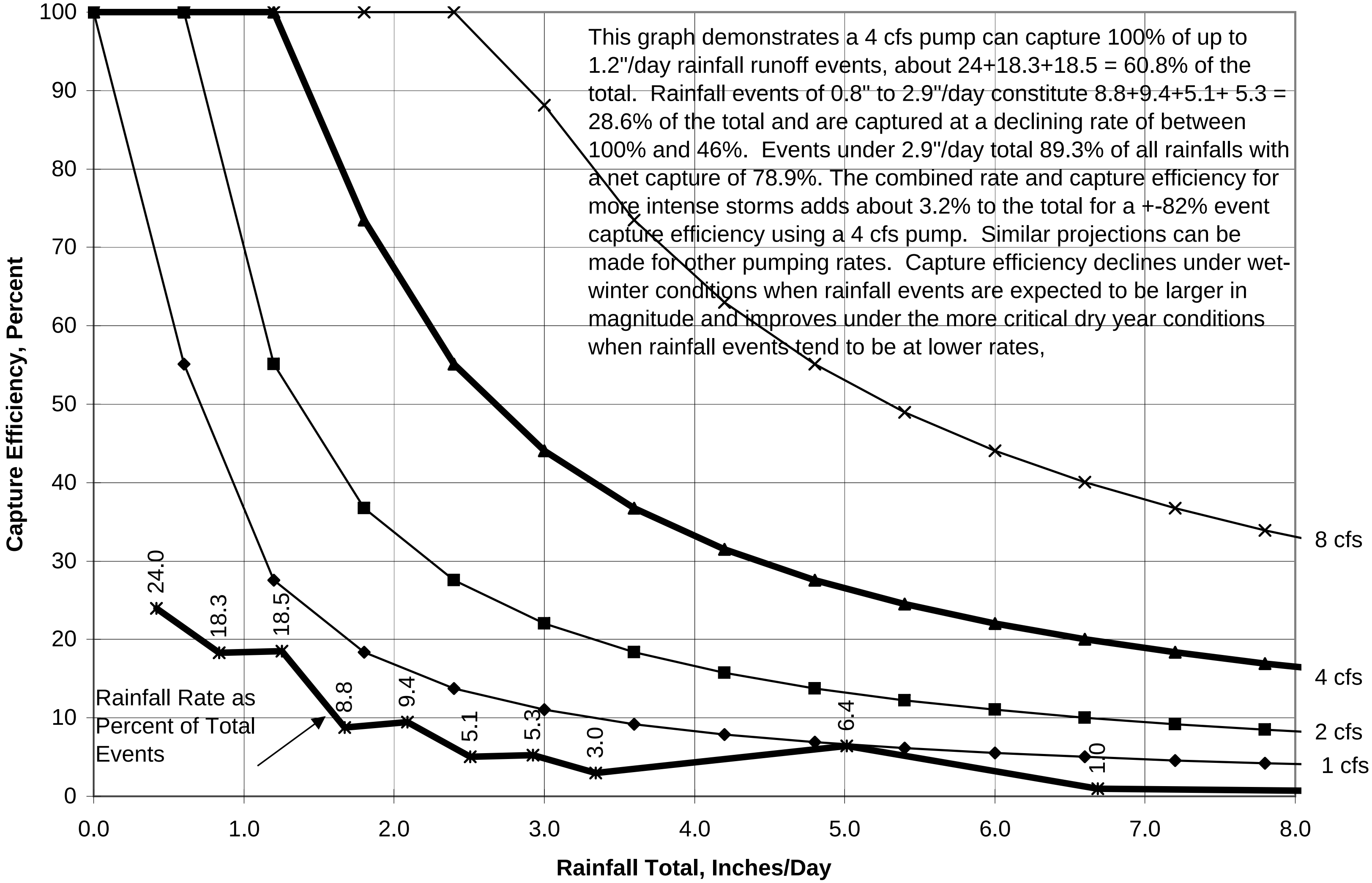

1, 2, 4, 8 CFS Sump Pump Capture Efficiencies
36 Acre Total Watershed, 30% Runoff
Figure 10
Capture Efficiency, Percent
Rainfall Rate, Inches/Hour
0
10
20
30
40
50
60
70
80
90
100
0.0
0.5
1.0
1.5
2.0
2.5
8 cfs pump
4 cfs pump
2 cfs pump
1 cfs pump

Figure 11


1, 2, 4, 8 CFS Sump Pump Capture Efficiencies
36 Acre Total Watershed, 50% Runoff
Capture Efficiency, Percent
Rainfall Rate, Inches/Hour
100
90
80
70
60
50
40
30
20
10
0
0.0
0.5
1.0
1.5
2.0
2.5
8 cfs pump
4 cfs pump
2 cfs pump
1 cfs pump

1, 2, 4, 8 CFS Sump Pump Rainfall Rate Capture Efficiencies Figure 12

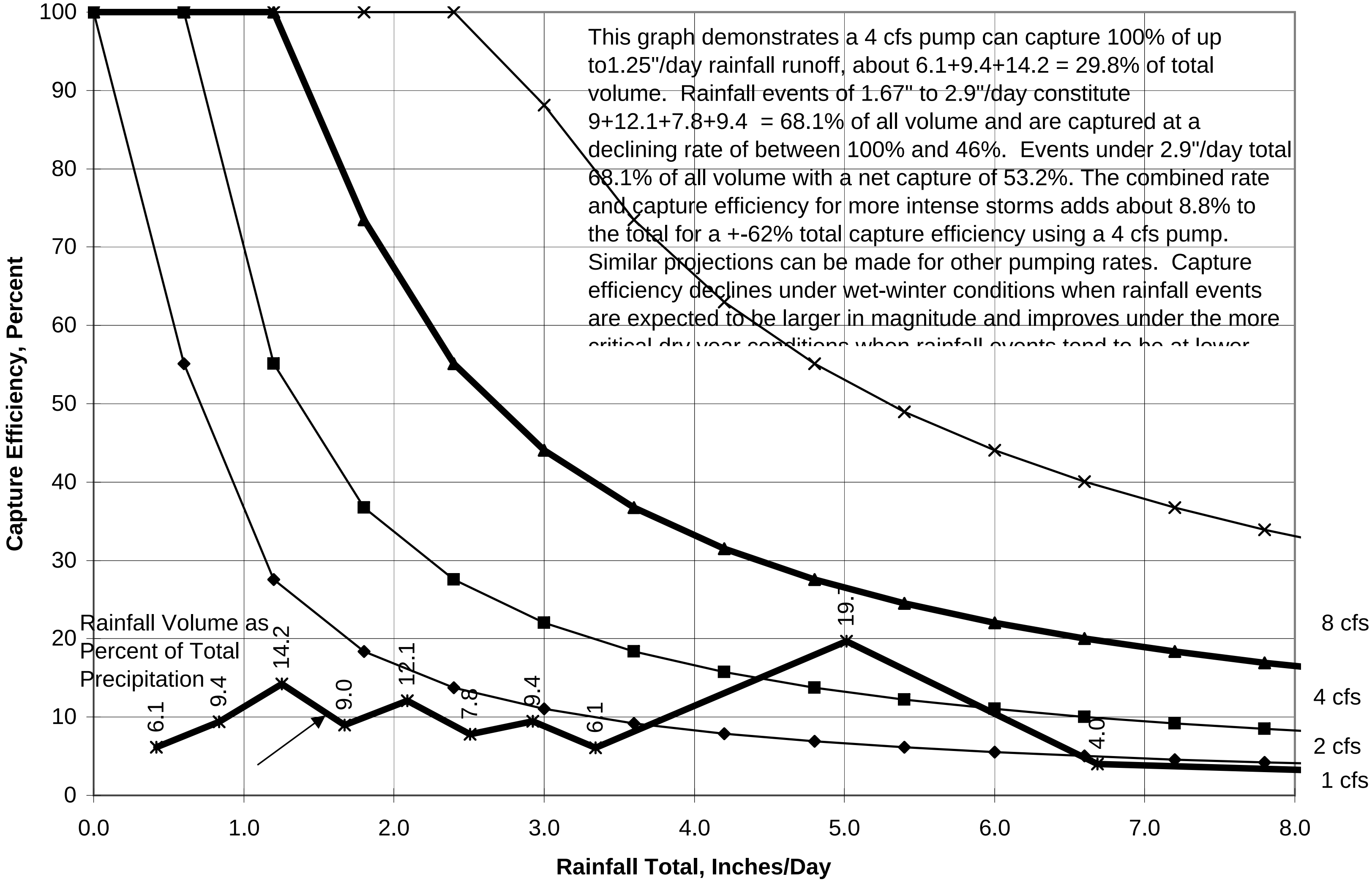
36 Acre Total Watershed, 50% Runoff Assumes 6-hour storm event

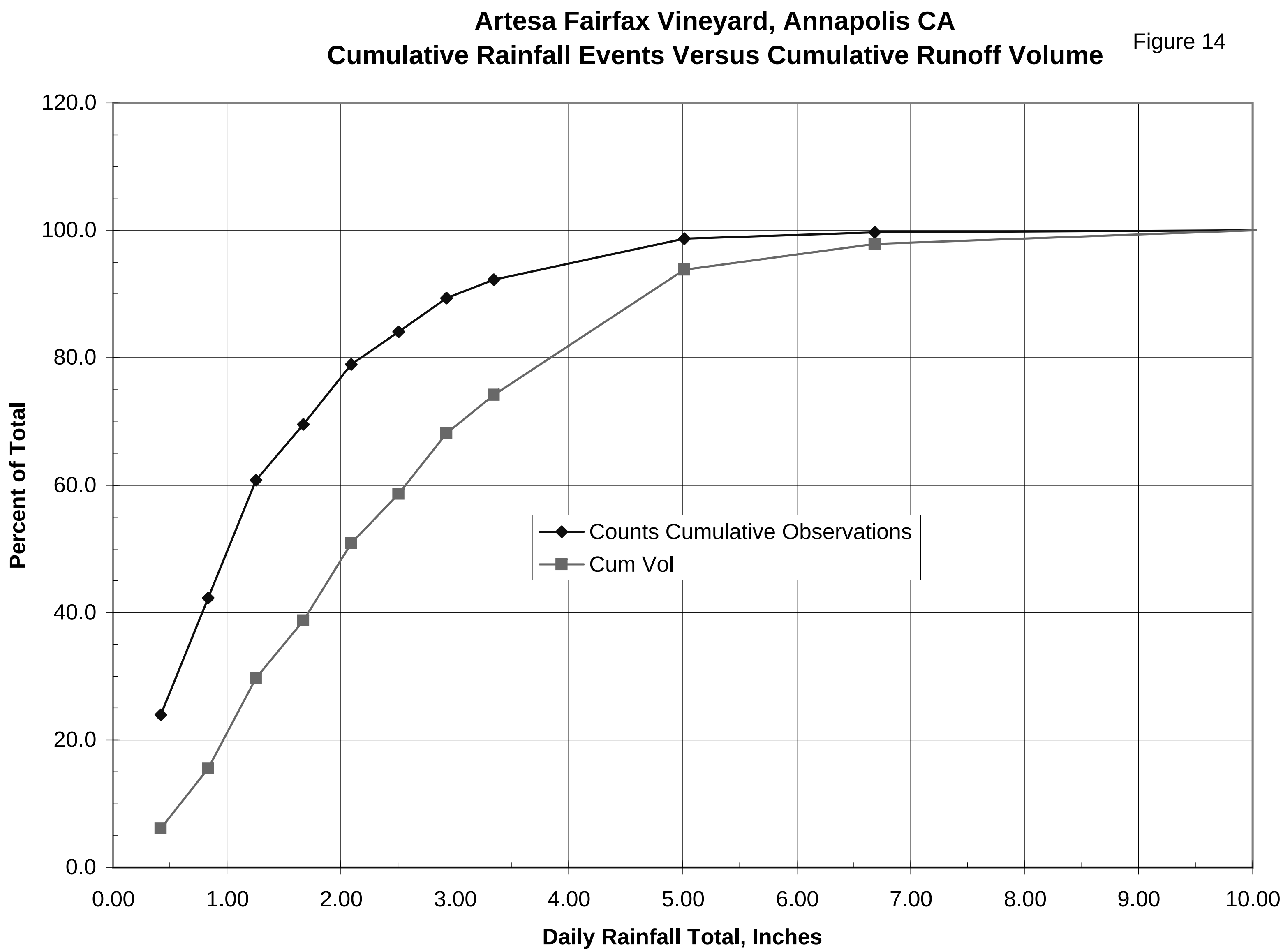


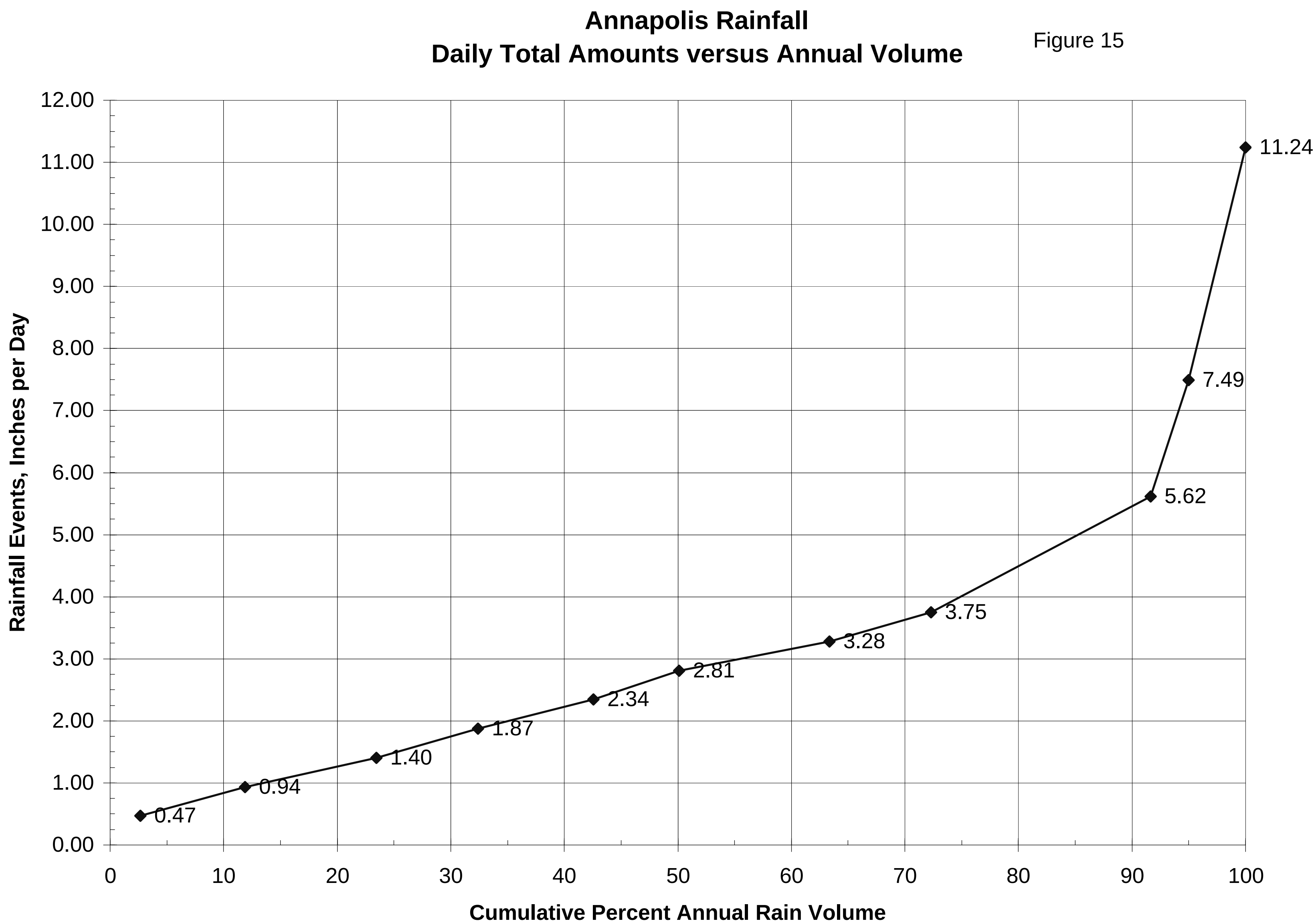
1, 2, 4, 8 CFS Sump Pump Rainfall Volume Capture Efficiencies
36 Acre Total Watershed, 50% Runoff

Figure 13

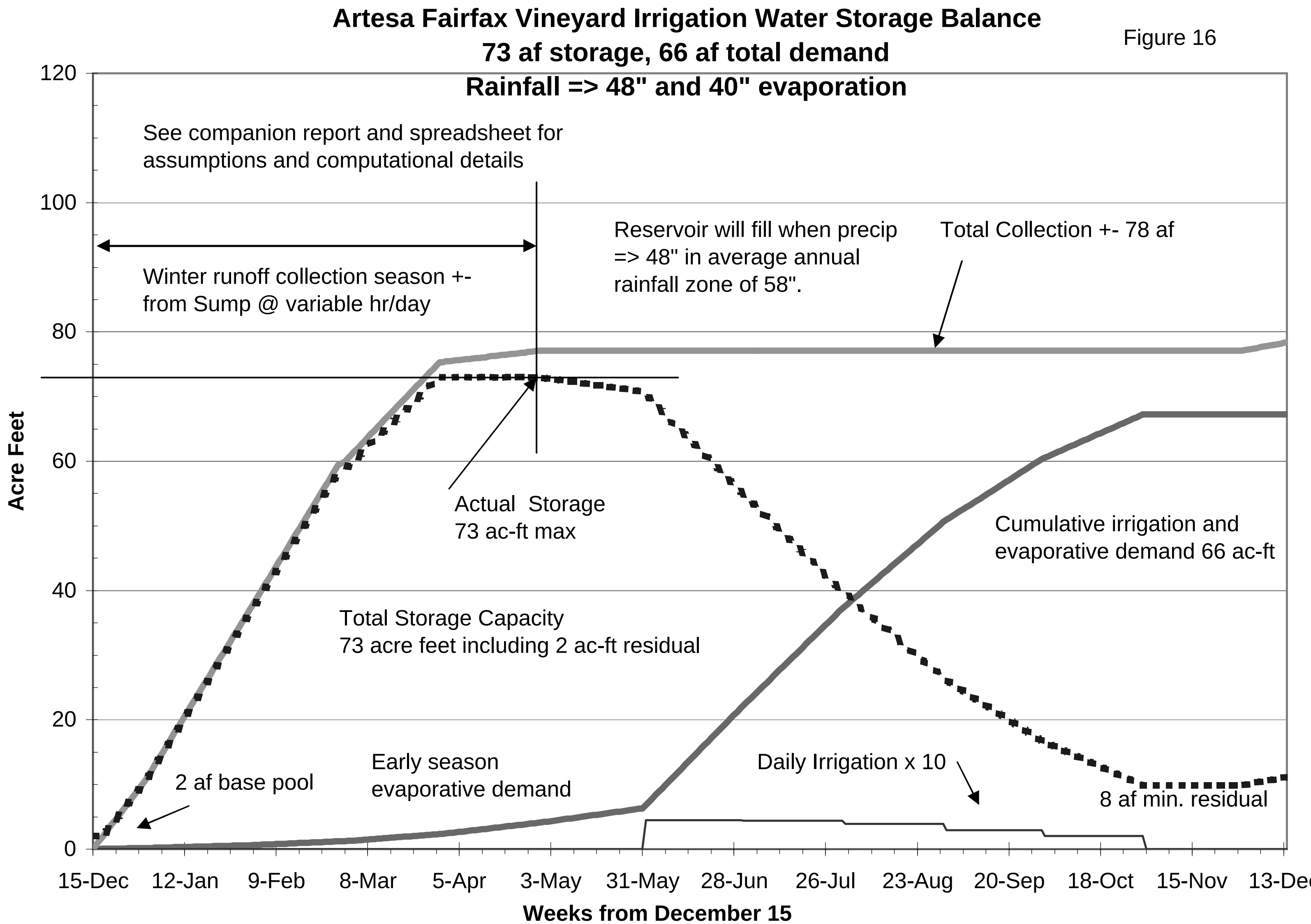
Assumes 6-hour storm event




Artesa Fairfax Vineyard, Annapolis CA
Cumulative Rainfall Events Versus Cumulative Runoff Volume
Figure 14
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Percent of Total
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
Daily Rainfall Total, Inches
Counts Cumulative Observations
Cum Vol



Annapolis Rainfall
Daily Total Amounts versus Annual Volume
Figure 15
Rainfall Events, Inches per Day
Cumulative Percent Annual Rain Volume
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0
10
20
30
40
50
60
70
80
90
100
0.47
0.94
1.40
1.87
2.34
2.81
3.28
3.75
5.62
7.49
11.24


Artesa Fairfax Vineyard Irrigation Water Storage Balance
73 af storage, 66 af total demand
Rainfall => 48" and 40" evaporation
Figure 16
See companion report and spreadsheet for
assumptions and computational details
Winter runoff collection season +-
from Sump @ variable hr/day
Reservoir will fill when precip
=> 48" in average annual
rainfall zone of 58".
Total Collection +- 78 af
Actual Storage
73 ac-ft max
Cumulative irrigation and
evaporative demand 66 ac-ft
Total Storage Capacity
73 acre feet including 2 ac-ft residual
2 af base pool
Early season
evaporative demand
Daily Irrigation x 10
8 af min. residual
Acre Feet
120
100
80
60
40
20
0
15-Dec
12-Jan
9-Feb
8-Mar
5-Apr
3-May
31-May
28-Jun
26-Jul
23-Aug
20-Sep
18-Oct
15-Nov
13-Dec
Weeks from December 15