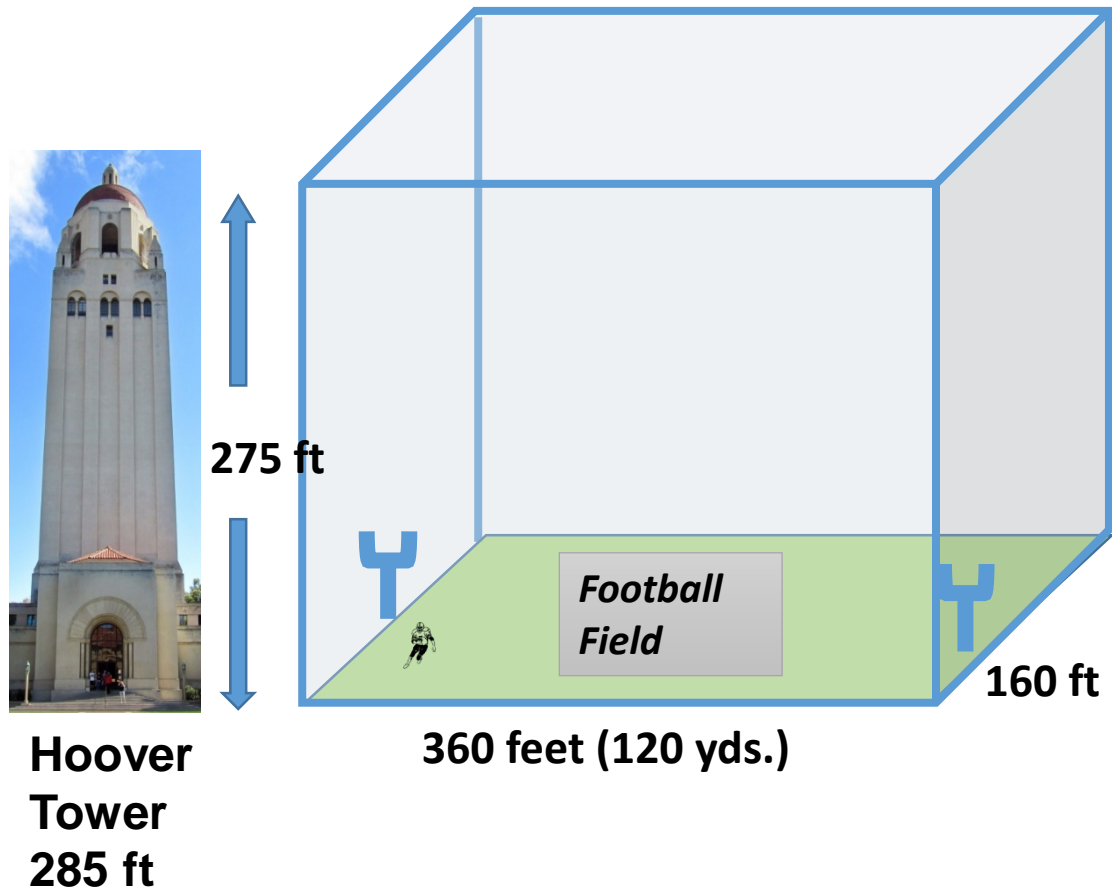


Groundwater Budget

Keith Bennett, Ph.D.
Save Palo Alto's Groundwater

Presentation to Palo Alto City Council
November 30, 2015

Groundwater used to build 14 residential basements (2015) equivalents



- 112 – 140 million gallons (343 – 430 acre-feet)
- 40+ gallons of water every day for every Palo Alto household (30,000) for 100 days
- More groundwater than Stanford used for irrigation (342 AF, 2011)
- Water provided annually by Hetch Hetchy for 4,000 customers.
- 20% of EPA's total annual water consumption

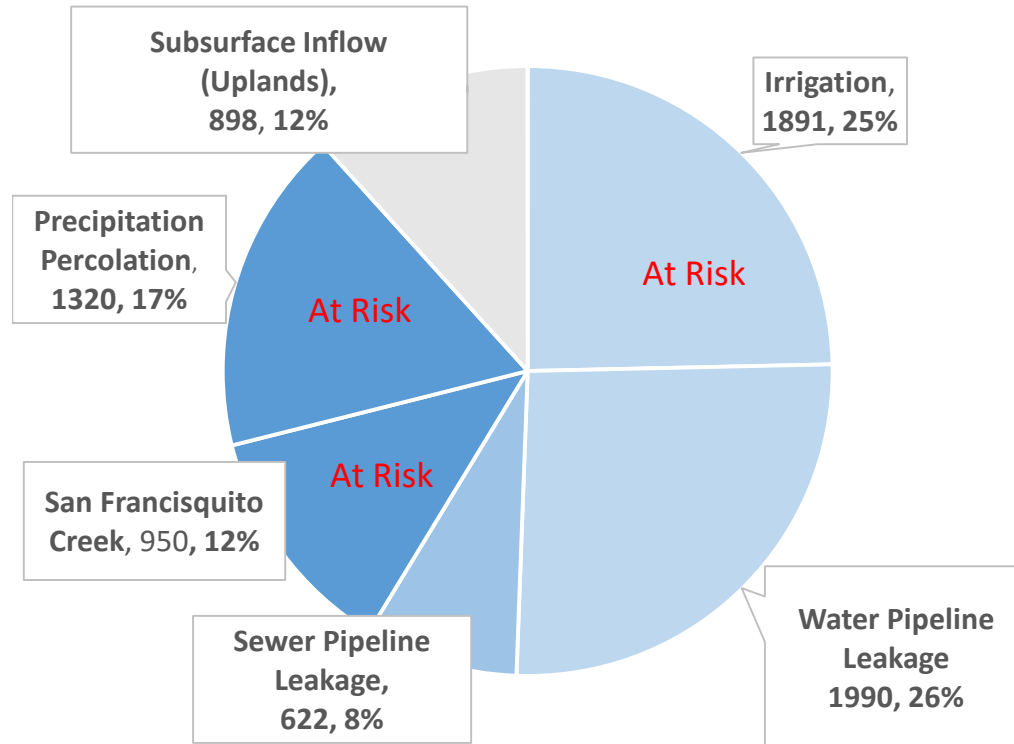
San Francisquito Creek Sub-basin Water Budget

$$\text{Inflow} - \text{Outflow} = \text{Storage Change}$$

Report: Gloria Way Production Well Alternatives Analysis & East Palo Alto Water Security Feasibility Study, Todd Engineers, 2012

<http://www.ci.east-palo-alto.ca.us/DocumentCenter/View/36>

Groundwater Inflow



Vast majority of inflow through local surface sources

Blue shadings: surface aquifer source

Local: ~2,170 AFY

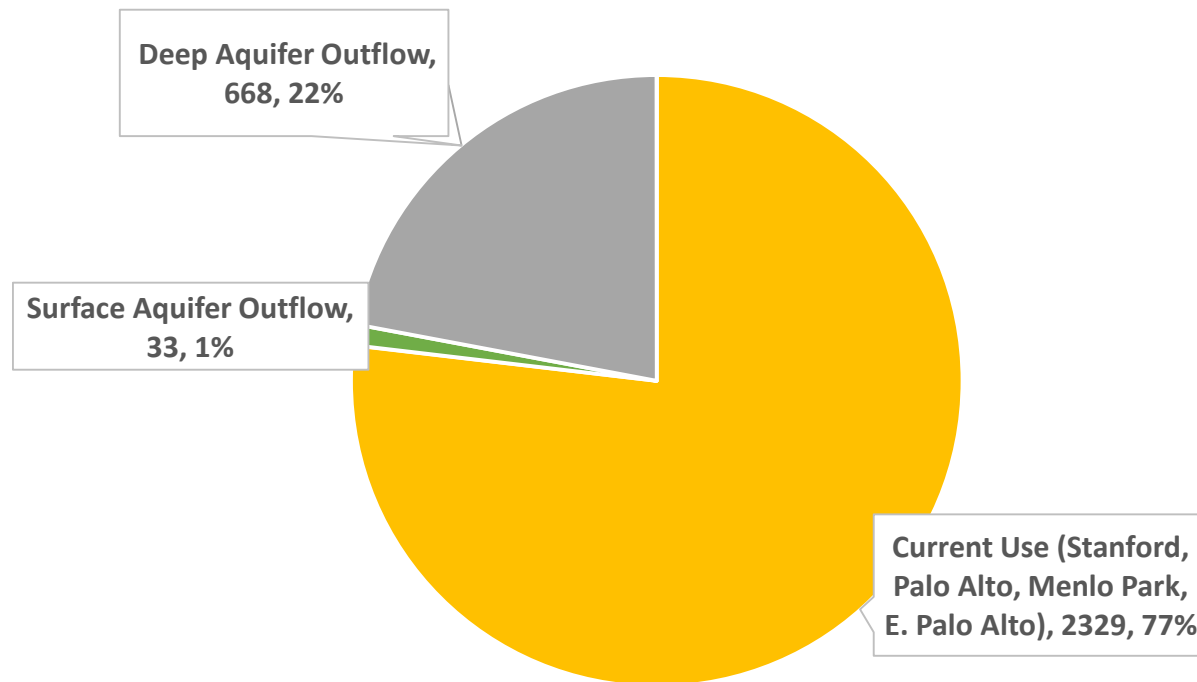
Imported: ~4,500 AFY

San Francisquito Creek Groundwater sub-basin includes most of Palo Alto, Stanford, Menlo Park, East Palo Alto & Atherton

Total: 7,670 acre-feet per year (AFY), midpoint of range
>50% at risk during drought

Source: Todd Engineers (2012), Table 8

Groundwater Outflow



Total: 3,028 acre-feet per year (AFY), midpoint of range

Only 33 AFY “flows to Bay”

Estimate does **not** include:

- Construction dewatering
 - Residential basements in Palo Alto (~400 AFY)
 - Residential basements other cities
 - Non-residential construction
- Future demands
- Emergency water supply

Source: Todd Engineers (2012), Table 9

Observations

- The amount of water used and dumped into the storm drains from construction dewatering is comparable to the planned annual groundwater produced from East Palo Alto's Gloria Way Supply Well (to be refurbished)
- Surface and deep aquifers are closely hydrologically connected
- Water from basement construction, currently dumped into the storm drains, should instead
 - Recharge deeper aquifers, thereby
 - Supplying potable water through Palo Alto's Emergency Groundwater Supply

Implement an immediate moratorium on the issuing of *new* dewatering permits for residential basements until:

- State and locally mandated drought restrictions are lifted, and
- Palo Alto includes a Sustainable Groundwater Management Plan in its Urban Water Master Plan

Palo Alto's policies must respect our groundwater as a valuable resource, not merely an inconvenient construction byproduct to be discarded.

Supplementary Materials

Table 7. Estimated Annual Groundwater Pumping
San Francisquito Groundwater Subbasin

Groundwater Pumping	Estimated Existing Use (AFY)	Estimated Potential Future Use¹ (AFY)	Estimated Emergency Supply Use¹ (AFY)
Atherton Private and Institutional Wells	710	890	
Private Wells Palo Alto, Menlo Park, East Palo Alto, and Redwood City	170	215	
O'Connor Tract Cooperative Water Company	84	100	
Palo Alto Park Mutual Water Company	523	218	
USGS, St. Patricks Seminary, Menlo College, and Veterans	500		
City of Redwood City		500 - 1,000	
City of Palo Alto			500/1,500 ²
City of Menlo Park		184	795
City of East Palo Alto		1,630	
Stanford University	342	410	
Total	2,329	4,547- 4947	1,295 - 2,295

Notes: AFY acre feet per year

¹ Future usage in year 2020 assuming a 20 percent reduction in Hetch Hetchy allocation

² 500 AFY sustainable yield, 1,500 AFY short-term yield, once every three years

Table 8. Estimated Annual Groundwater Recharge
San Francisquito Groundwater Subbasin

Irrigation Return Flow	Annual Water ² Importation (AFY)	Surface ² Water (AFY)	Groundwater (AFY)	Total Water Use (AFY)	LOW	HIGH	Percolation to Groundwater		
					30% Used for Irrigation (AFY)	50% Used for Irrigation (AFY)	LOW x 10% (AFY)	HIGH x 15% (AFY)	
Redwood City ¹	5,383			5,383	1,615	2,691	161	404	
CWSC -Atherton and Menlo Park ³	8,426	834		9,260	2,778	4,630	278	695	
Private			880	880	264	440			
Menlo Park MWD	3,574			3,574	1,072	1,787	107	268	
East Palo Alto	1,935			1,935	580	967	58	145	
Palo Alto	12,311			12,311	3,693	6,156	369	923	
Stanford	2,396	809	342	3,547	1,064	1,774	106	266	
Irrigation Percolation Total							1,080	2,701	
Water Pipeline Leakage				Total Water Use (AFY)			LOW - 3% (AFY)	HIGH - 5% (AFY)	
Redwood City ¹				9,689			291	484	
CWSC -Atherton and Menlo Park ³				16,668					
Private				1,584			48	79	
Menlo Park MWD				6,433			193	322	
East Palo Alto				3,482			104	174	
Palo Alto				22,160			665	1,108	
Stanford				6,385			192	319	
Water Pipeline Leakage							1,492	2,487	
Sewer Pipeline Leakage				Total Water Use (AFY)			LOW - 0.5% (AFY)	HIGH - 2% (AFY)	
Redwood City ¹				9,689			48	194	
CWSC -Atherton and Menlo Park ³				16,668					
Private				1,584			8	32	
Menlo Park				6,433			32	129	
East Palo Alto				3,482			17	70	
Palo Alto ¹				22,160			111	443	
Stanford				6,385			32	128	
Sewer Leakage							249	995	
Surface Water Infiltration							Recharge to Groundwater (AFY)	(AFY)	
San Francisquito Creek							Surface Water Infiltration	950	950
Recharge from Precipitation			Basin Area (acres)	Annual Rainfall (feet)	Rainfall on Basin Area (AFY)		Rainfall Percolation to Groundwater LOW - 5% (AFY) HIGH - 10% (AFY)		
Alluvial Basin			14,080	1.25	17,600		880	1,760	
Subsurface Inflow		Watershed Area (acres)	Annual Rainfall (feet)	Rainfall on Watershed Area (AFY)	Percolation to Upland 5% (AFY)		Subsurface Inflow to Alluvial Basin LOW - 25% (AFY) HIGH - 50% (AFY)		
Uplands		23,936	2	47,872	2,394		598	1,197	
Total							5,001	10,089	

AFY - acre-feet per year

CWSC - California Water Service Company

MWD Municipal Water District

¹ SFPUC use reduced by half since only approximately half of city within San Francisquito Subbasin.

² FY 2009-10 usage reported in BAWSCA Annual Summary

³ Assume 70% of CWSC Bear Gulch SFPUC Purchases go to Atherton and Menlo Park

Table 9. Estimated Annual Groundwater Discharge
San Francisquito Groundwater Subbasin

Groundwater Pumping and Consumptive Use	Estimated Existing Use (AFY)			Consumption 95% (AFY)
Atherton Private and Institutional Wells	710			675
Private Wells Redwood City, Menlo Park, East Palo Alto, and Palo Alto	170			162
O'Connor Tract Cooperative Water Company	84			80
Palo Alto Park Mutual Water Company	523			497
USGS, St. Patricks Seminary, Menlo College, and Veterans	500			475
Stanford	342			325
Total Consumption				2,213
Subsurface Outflow Q = L x T x dh/dl	Width	T	dh/dl	Outflow (AFY)
	(feet)	(gpd/ft)	(ft/ft)	
Shallow Aquifer	29,800	2,000	0.0005	33
Deep Aquifer	29,800	10,000	0.002	668
Total Subsurface Outflow				701
Total Groundwater Discharge (AFY)				2,914