ONE-PAGE PLACE ASSESSMENT: SAN FRANCISCO, CALIFORNIA

LOCATED IN THE SAN FRANCISCO BAY SUBWATERSHED WITHIN THE CALIFORNIA WATERSHED

CLIMATE ⚐1

AVERAGE HIGH & LOW TEMPERATURES[1] — 1914 – 2013

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
°F HIGH	56.5	59.8	61.5	62.8	63.9	66.1	65.8	66.6	69.8	69.1	63.7	57.3	63.6
°F LOW	45.7	47.9	48.8	49.7	51.1	52.9	53.7	54.5	55.5	54.4	51.0	46.8	51.0
°C HIGH	13.6	15.4	16.4	17.1	17.7	18.9	18.8	19.2	21.0	20.6	17.6	14.1	17.6
°C LOW	7.6	8.8	9.3	9.8	10.6	11.6	12.1	12.5	13.1	12.4	10.6	8.2	10.6

RECORD HIGH[1]: 103° F | 39.4° C | *July 17, 1988*

RECORD LOW[1]: 27° F | -2.8° C | *December 11, 1932*

SUN ⚐2

LATITUDE: 37.8°

ELEVATION: 51 FT / 15.5 m

	MAR 21	JUN 21	SEP 21	DEC 21
DEGREES N or S of DUE EAST THE SUN RISES[2]	0°	31°N	0°	30°S
DEGREES N or S of DUE WEST THE SUN SETS[2]	0°	31°N	0°	30°S
SOLAR-NOON ALTITUDE ANGLE (ABOVE HORIZON)[a,2,3]	52°	76°	52°	29°

SOLAR-NOON WINTER-SOLSTICE SHADOW RATIO[b]: 1 : 1.82 ...AND AZIMUTH[c]: 0°

9AM & 3PM WINTER-SOLSTICE SHADOW RATIO[b,2]: 1 : 3.56 ...AND AZIMUTH[c,2]: 42°

WIND ⚐3

MAX SPEED[4]: 71 MPH | 114 km/h

PREVAILING WIND DIRECTION (FROM WHERE)[4] & AVERAGE SPEED[5]

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
	N	NW	W	W	W	W	W	W	W	W	NW	N	
MPH	6.7	8.2	10.2	12.1	13.6	14.1	12.9	12.3	10.6	9.0	7.2	7.2	10.3
km/h	10.8	13.2	16.4	19.5	21.9	22.7	20.8	19.8	17.1	14.5	11.6	11.6	16.6

WATER ⚐4

AVERAGE RAINFALL (GAIN)[1] — 1914 – 2013

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
INCHES	4.35	3.81	2.90	1.42	0.57	0.16	0.02	0.05	0.22	1.05	2.57	4.04	21.16
mm	110.5	96.8	73.7	36.1	14.5	4.1	0.5	1.3	5.6	26.7	65.3	102.6	537.5

AVERAGE PAN EVAPORATION (POTENTIAL LOSS)[d,6]

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
INCHES	1.7	2.4	3.8	5.3	6.4	7.1	6.7	6.6	5.9	4.4	2.4	1.7	54.4
mm	43.2	61.0	96.5	134.6	162.6	180.3	170.2	167.6	149.9	111.8	61.0	43.2	1,381.8

WETTEST YEAR'S RAIN[1]: 43.8 INCHES | 1,111 mm | *1983*

DRIEST YEAR'S RAIN[7]: 5.6 INCHES | 142 mm | *2013*

LONGEST PERIOD WITH NO MEASURABLE PRECIPITATION[8]: 199 DAYS: *MARCH 21 – SEPTEMBER 16, 1982*

RAINFALL INCOME[e]: 57 GPCD / 216 lpcd

AREA[f,9]: 46.87 SQ MILES / 121.3 km²

POPULATION[f,9]: 825,863 *2012 est.*

UTILITY-WATER USE[g,10]: 49 GPCD / 185 lpcd

HISTORICAL | DEPTH TO GROUNDWATER[h,11,12] | CURRENT

CURRENT GROUNDWATER EXTRACTION | NATURAL GROUNDWATER RECHARGE[i,13,14]

WATERGY ⚐5

of AVG CA HOMES THAT COULD BE POWERED W/ ENERGY TO MOVE & TREAT SF's WATER[j,15, 16]: 1,480

TOTEM SPECIES ⚐6

MEGAFAUNA: Southern sea otter *(Enhydra lutris nereis)*

MAMMAL: Townsend's big-eared bat *(Corynorhinus townsendii)*

FISH: Delta smelt *(Hypomesus transpacificus)*

AMPHIBIAN: California red-legged frog *(Rana draytonii)*

INSECT: Bay checkerspot butterfly *(Euphydryas editha bayensis)*

BIRD: California black rail *(Laterallus jamaicensis coturniculus)*

PLANT: San Francisco popcorn flower *(Plagiobothrys diffusus)* [17]

FOR MORE INFORMATION & HOW TO APPLY IT

⚐**1.** For more CLIMATE information, see the introduction, chapters 1, 2, & 4, and appendix 5 of *Rainwater Harvesting for Drylands and Beyond (RWHDB), Volume 1, 2nd Edition*

⚐**2.** For more SUN information, see chapters 2 & 4 and appendices 5 & 7

⚐**3.** For more WIND information, see chapters 2 & 4 and appendices 5 & 9

⚐**4.** For more WATER information, see the introduction, chapters 1–4, and appendices 1–5

⚐**5.** For more WATERGY information, see chapters 2 & 4 and appendix 9

⚐**6.** For more TOTEM SPECIES information: the ethics, principles, and strategies throughout *RWHDB* help us shift from a negative to a positive impact on these species and their habitats and ecosystems, on which our quality of life also depends.

SAN FRANCISCO PLACE-ASSESSMENT NOTES

a. Altitude angle (a.k.a., elevation angle) refers to the number of degrees the sun is located above the horizon at a given time and date.

b. The solar-noon winter-solstice shadow ratio is the object's height : length of object's shadow cast on December 21 at noon (the longest noontime shadow of the year). The ratio is 1 : x, where x = 1 ÷ tangent (90 - (latitude + 23.44)).

c. Azimuth is the angle formed between a reference direction (here, due south) to the point on the horizon directly below a given object. Solar noon is the time on any day when the sun's azimuth is 0°. The 9 am & 3 pm winter-solstice azimuth indicates the sun's deviation, in degrees, east/west of due south at those times (–/+ 3 hours from solar noon) on December 21.

d. An evaporation pan holds water whose depth is measured daily as water evaporates. These data allow us to determine evaporation rates at a given location. Compare average rainfall (water gain) to potential water loss via evaporation by looking up pan-evaporation rates for your area. According to one definition, if pan-evaporation rates exceed rainfall rates, you are in a dryland environment. Another definition states that drylands are "land areas where the mean annual precipitation is less than two thirds of potential evapotranspiration (potential evaporation from soil plus transpiration by plants), excluding polar regions and some high mountain areas which meet this criterion but have completely different ecological characteristics" (Greenfacts.org). Stated as a ratio of rainfall to pan evaporation, the cut-off for drylands is 1:1.5; when the number on the right is higher than 1.5, the environment is drylands. The higher the ratio of potential evaporation to rainfall, the more important evaporation-reducing strategies such as mulch, windbreaks, shading, and covered water storage become. The data above for San Francisco, estimated totals computed from meteorological measurements using a form of the Penman equation, yield a rainfall:pan-evaporation ratio of 1:2.57. Therefore, per both definitions above, San Francisco's is a drylands environment.

e. Calculated in situ w/ average rainfall, area, & population

f. City proper

g. San Francisco's given gpcd is the average retail per-capita use of the 10-year period from FY 2000–2001 to FY 2009–2010.

h.

i.

j. Calculated with 49 gpcd (ref. 10), population = 825,863 (ref. 9), energy-for-water of 72.4 Wh/100 gallons (ref. 15), annual residential energy usage in California = 90.11 billion kWh (ref. 16), number of CA households = 12,466,331 (ref. 9).

CREDITS: Brad Lancaster, Resource concept **| Megan Hartman,** Resource creation & research

SAN FRANCISCO PLACE-ASSESSMENT REFERENCES

1. San Francisco Mission Dolore station (#047772), wrcc.dri.edu, accessed 12/26/2013

2. Rainwater Harvesting for Drylands & Beyond, Vol 1, or esrl.noaa.gov/gmd/grad/solcalc, accessed 12/26/2013

3. RWHDB Vol 1, or Mar 21 = 90–latitude, Jun 21 = 90–(latitude–23.44), Sep 21 = 90–latitude, Dec 21 = 90–(latitude+23.44)

4. www.myforecast.com/bin/climate.m?city=12156, accessed 12/26/2013

5. San Francisco Int'l Airport, 1996–2006, www.wrcc.dri.edu/climatedata/climtables/westwind/#CALIFORNIA, accessed 12/26/2013

6. www.calclim.dri.edu/ccda/comparative/avgpan.html, accessed 12/26/2013

7. www.weather.com/news/weather-forecast/california-record-driest-year-20131115, accessed 2/7/2014

8. San Francisco Oceaside station #047767, per Michelle Breckner, Service Climatologist, WRCC, via phone 2/10/2014

9. Census.gov, accessed 12/26/2013

10. San Francisco Public Utilities Commission's Water Resources, Fiscal Year 2012–2013 Annual Report, available at sfwater.org/modules/showdocument.aspx?documentid=4626, accessed 2/8/2014

11.

12.

13.

14.

15. "Embedded Energy in Water Studies," 2000 data, energydataweb.com, accessed 9/6/2010

16. Electricity Data Browser, eia.gov, accessed 2/8/2014

17. Delta smelt suggested by Elizabeth Dougherty of WhollyH2O.com, via telephone, 2/10/2014