ONE-PAGE PLACE ASSESSMENT: TUCSON, ARIZONA

LOCATED IN THE SANTA CRUZ RIVER SUBWATERSHED WITHIN THE COLORADO RIVER WATERSHED

SUN ⚐1

LATITUDE 32.2°

ELEVATION 2,555 FT / 779 m

	MAR 21	JUN 21	SEP 21	DEC 21
DEGREES N or S of DUE EAST THE SUN RISES[1]	0°	29°N	0°	27°S
DEGREES N or S of DUE WEST THE SUN SETS[1]	0°	29°N	0°	27°S
SOLAR-NOON ALTITUDE ANGLE (ABOVE HORIZON)[a,1,2]	58°	81°	58°	34°

SOLAR-NOON WINTER-SOLSTICE SHADOW RATIO[b] 1 : 1.46 …AND AZIMUTH[c] 0°

9AM & 3PM WINTER-SOLSTICE SHADOW RATIO[b,1] 1 : 2.79 …AND AZIMUTH[c,1] 44°

CLIMATE ⚐2

AVERAGE HIGH & LOW TEMPERATURES[3] *1946 – 2022*

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
°F HIGH	65.4	68.6	74.1	82.2	90.7	100.3	99.4	97.4	94.4	85.2	73.9	65.5	83.1
°F LOW	39.1	41.3	45.6	51.6	59.3	69.0	74.4	73.0	68.4	57.3	46.0	39.4	55.5
°C HIGH	18.6	20.3	23.4	27.9	32.6	37.9	37.4	36.3	34.7	29.6	23.3	18.6	28.4
°C LOW	3.9	5.2	7.6	10.9	15.2	20.6	23.6	22.8	20.2	14.1	7.8	4.1	13.1

RECORD HIGH[4] 118° F | 47.8° C | *June 27, 1990*

RECORD LOW[4] 6° F | -14.4° C | *January 7, 1913*

WIND ⚐3

MAX SPEED[8] 80 MPH | 129 km/h

PREVAILING WIND DIRECTION (FROM WHERE)[6] & AVERAGE SPEED[7]

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
	ESE	ESE	WSW	WSW	WSW	WSW	SE	ESE	ESE	ESE	ENE	ESE	
MPH	7.5	7.7	8.3	8.7	8.6	8.5	8.3	7.8	8.1	7.9	7.7	7.3	8.0
km/h	12.1	12.4	13.4	14.0	13.8	13.7	13.4	12.6	13.0	12.7	12.4	11.7	12.9

WATER ⚐4

AVERAGE RAINFALL (GAIN)[3] *1946 – 2022*

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
INCHES	0.86	0.72	0.63	0.28	0.17	0.24	2.45	2.15	1.36	0.82	0.58	0.95	11.21
mm	21.8	18.3	16.0	7.1	4.3	6.1	62.2	54.6	34.5	20.8	14.7	24.1	284.7

AVERAGE PAN EVAPORATION (POTENTIAL LOSS)[d,9] *1894 – 2005*

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
INCHES	3.25	4.57	6.95	9.88	12.87	14.91	13.17	11.65	10.35	7.81	4.73	3.37	103.51
mm	82.6	116.1	176.5	251.0	326.9	378.7	334.5	295.9	262.9	198.4	120.1	85.6	2,629.2

WETTEST YEAR'S RAIN[4] 26.22 INCHES | 666 mm | *1983*

DRIEST YEAR'S RAIN[5] 4.17 INCHES | 106 mm | *2020*

LONGEST PERIOD WITH NO MEASURABLE PRECIPITATION[10]

155 DAYS: *DECEMBER 27, 1971 – MAY 29, 1972*

RAINFALL INCOME[e] 223 GPCD / 844 lpcd

AREA[f,11] 226.7 SQ MILES / 587 km²

POPULATION[f,11] 542,629 *2020*

UTILITY-WATER USE[12] 82 GPCD / 311 lpcd

HISTORICAL 30 FT | 9.25 m | *1950*

DEPTH TO GROUNDWATER[g,13] 120 FT | 36.49 m | *2011* CURRENT

CURRENT GROUNDWATER EXTRACTION > NATURAL GROUNDWATER RECHARGE[h,i,14,15]

WATERGY ⚐5

% MUNICIPAL ENERGY CONSUMPTION USED TO MOVE & TREAT WATER[16] 44%

TOTEM SPECIES ⚐6

AMPHIBIAN: Lowland Leopard Frog[j,17] MAMMAL: Mexican Long-Tongued Bat[17]

FISH: Sonora Suckerfish[j,17] BIRD: Rufous-Winged Sparrow[j,17] REPTILE: Mexican Garter Snake[j,17]

PLANT: Tumamoc Globeberry[17] MEGAFAUNA: Mexican Gray Wolf,[j,18] Jaguar,[j,19] Grizzly Bear (Catalina-Rincon Mtns)[j,20]

FOR MORE INFORMATION & HOW TO APPLY IT

⚐ **1.** For more SUN information, see chapters 2 & 4 and appendices 5 & 7 of *Rainwater Harvesting for Drylands and Beyond (RWHDB), Volume 1, 2nd Edition*

⚐ **2.** For more CLIMATE information, see the introduction; chapters 1, 2, & 4; and appendix 5

⚐ **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.

TUCSON PLACE-ASSESSMENT NOTES

a. The solar-noon altitude angle (a.k.a., solar-noon elevation angle) refers to the number of degrees the sun is located above the equator-facing horizon at solar noon on the given date. In the northern hemisphere, the equator-facing horizon is to the south. In the southern hemisphere, the equator-facing horizon is to the north.

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 checking pan-evaporation rates for your area. If pan-evaporation rates exceed rainfall rates, you are in a dryland environment, where evaporation-reducing strategies such as mulch, windbreaks, shading, and covered water storage are very important.

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

f. City proper

g. Depths to groundwater vary widely in Tucson Basin wells. This Tucson Water well (Local ID D-14-13 13CBC) is very close to downtown Tucson, the Santa Cruz River, and their histories. It is within 600 yards (547 m) of a hand-dug well on South Main Street (near El Tiradito or the Wishing Shrine) from which in the 1870s Adam Sanders and Joseph Phy obtained water to sell at 5¢ per bucket. According to "The Lessening Stream: An Environmental History of the Santa Cruz," by Michael F. Logan, "The two entrepreneurs filled an iron tank on a wagon from their well and traveled daily through town selling water. Within 25 years municipal water use in Tucson would progress from well water sold by the bucket, to a piped supply tapping the aquifer. When the mains were first opened in September 1882, an almost immediate decline in the water table downstream resulted."

h. Due to rapidly depleting groundwater tables and associated surface water in areas of Arizona with a heavy reliance on mined groundwater, the *1980 Groundwater Management Code* identified and designated five such areas as Active Management Areas (AMAs), and mandated that they attain *safe yield*, on an AMA-wide basis, by the year 2025. Safe yield, according to the 2010 Arizona Department of Water Resources DRAFT Demand and Supply Assessment of the Tucson Active Management Area, is "a balance between the amount of groundwater pumped from the AMA annually, and the amount of water naturally or artificially recharged. Groundwater withdrawals in excess of natural and artificial recharge lead to an overdraft of the groundwater." All projections from the Assessment predict the Tucson AMA will *not* attain safe yield by 2025.
None of the projections presented in the Assessment consider the potential benefit of wide promotion and adoption of the on-site harvest of on-site waters as advocated in this book.

i. Groundwater levels are rising in some parts of the Tucson Active Management Area (AMA) due to reduced groundwater pumping in those areas, and where purchased CAP water (i.e., Colorado River water imported 300+ miles (483+ km) via the Central Arizona Project canal and its pumping stations) is being used instead of groundwater or to artificially recharge groundwater. Groundwater pumping can also be reduced with the on-site harvest of free on-site waters as advocated in this book. In addition, energy conservation and renewable on-site power production can reduce groundwater pumping associated with thermoelectric-energy production. See appendix 9 to compare the costs of our water and energy options.

CREDITS: Brad Lancaster: Resource concept, content oversight, research | Megan Hartman: Resource creation, research

TUCSON PLACE-ASSESSMENT REFERENCES

1. Rainwater Harvesting for Drylands & Beyond, Vol 1, or esrl.noaa.gov/gmd/grad/solcalc, accessed 1/13/2019

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

3. Tucson International Airport station (#028820), wrcc.dri.edu/my, accessed 7/1/2022. *Note: While the period of record is longer for station #028815, the airport station's data are more current (through 2022); the two stations' averages do not*

substantially differ.

4. Tucson Magnetic Observatory station (#028800), wrcc.dri.edu, accessed 7/1/2022

5. Tucson International Airport station (#028820), wrcc.dri.edu/my, accessed 7/1/2022

6. Prevailing Winds, Arizona (Source: Kansas State University), ftp-fc.sc.egov.usda.gov/AZ/NRI/prevailing_winds.pdf, accessed 2/6/2012

7. Custom Wind Rose Plots, Tucson International Airport 1948–2019, 16-bin, mesonet.agron.iastate.edu, accessed 1/13/2019

8. Record Wind Speed; Tucson, AZ; Special Reports: Historical Climate, myforecast.com, accessed 1/13/2019

9. Average Pan Evaporation Data by State, Arizona, Tucson Univ of Arizona; wrcc.dri.edu/Climate/comp_tables.php, accessed 7/1/2022

10. Number of Consecutive Days Precipitation < 0.01, Tucson Magnetic Obsy (#028800); scacis.rcc-acis.org, accessed 7/1/2022

11. Data.census.gov, accessed 7/1/2022

12. Tucson Water — 2017 Facts and Figures, Residential GPCD, www.tucsonaz.gov/water/about-us, accessed 1/15/2019
[Data presented in this resource as 82.2; rounded to whole number per Brad's discretion]

13. Water Levels: Standard Water Levels, gisweb.azwater.gov/gwsi/Detail.aspx, accessed 1/13/2019
Well: Local ID D-14-13 13CBC, Site ID 321227110574801, Registry ID 619923, Latitude 32° 12′ 38.5″, Longitude 110° 58′ 33.4″, Altitude 2368′, Water Use – Public Supply, Drill date 3/1/1946
[Data presented in this resource as 30.35 and 119.7 feet, respectively; rounded to whole numbers per Brad's discretion]

14. Demand & Supply Assessment DRAFT, Tucson Active Management Area, May 28, 2010, Arizona Dept of Water Resources www.azwater.gov/AzDWR/WaterManagement/Assessments/documents/FINALTAMAASSESSMENT.pdf, accessed 2/17/2012

15. "Gains Seen on Area's Water Goals," Tony Davis, Arizona Daily Star, Monday, January 30, 2012, p. A1

16. 2007 data from Bruce Plenk, City of Tucson Solar Energy Coordinator, via email 3/22/2010

17. Priority Vulnerable Species in Pima County, pima.gov/cmo/sdcp/species/fsheets/vuln/vuln.html, accessed 11/2/2011

18. Lobos of the Southwest, Mapping the Lobos Range, mexicanwolves.org/index.php/wolf-country, accessed 1/8/2013

19. "Jaguar Sighted Near Tucson," Jonathan DuHamel, Tucson Citizen, 11/21/2011, tucsoncitizen.com/wryheat/2011/11/21/jaguar-sighted-near-tucson, accessed 1/8/2013

20. "Series Reminds: Once Grizzlies Roamed Nearby," Doug Kreutz, Arizona Daily Star, 1/30/2012, azstarnet.com/mobi/news/article_357f3ef5-74e4-5d65-839c-87248b982688.html, accessed 1/8/2013