# ONE-PAGE PLACE ASSESSMENT: BENSON, AZ

LOCATED IN THE - CASTANERA SPRING - SUBWATERSHED WITHIN THE - SAN PEDRO RIVER - WATERSHED

## SUN ⚐2

LATITUDE 31.9°

ELEVATION 3,586 FT / 1093 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,2] | 58° | 82° | 58° | 35° |

SOLAR-NOON WINTER-SOLSTICE SHADOW RATIO[b,1] 1 : 1.45 ...AND AZIMUTH[c] 0°

9AM & 3PM WINTER-SOLSTICE SHADOW RATIO[b,1] 1 : 2.76 ...AND AZIMUTH[c,1] 46°

## CLIMATE ⚐1

AVERAGE HIGH & LOW TEMPERATURES[3] *1991 - 2020*

| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F HIGH | 64.7 | 68.0 | 74.4 | 81.4 | 89.7 | 99.0 | 97.5 | 95.2 | 92.0 | 84.2 | 73.3 | 64.4 | 81.1 |
| F LOW | 27.1 | 30.1 | 35.3 | 41.0 | 48.7 | 57.7 | 65.9 | 64.8 | 58.1 | 45.1 | 33.6 | 26.9 | 44.2 |
| C HIGH | 18.2 | 20.0 | 23.6 | 27.4 | 32.1 | 37.2 | 36.4 | 35.1 | 33.3 | 29.0 | 22.9 | 18.0 | 27.3 |
| C LOW | -2.7 | -1.1 | 1.8 | 5.0 | 9.3 | 14.3 | 18.8 | 18.2 | 14.5 | 7.3 | 0.9 | -2.8 | 6.8 |

RECORD HIGH[3] 112° F | 44.4° C | *6/21/2017* RECORD LOW[3] -7° F | -21.7° C | *12/08/1978*

## WIND ⚐3

MAX SPEED[5] 83 MPH | 134 kmph

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

| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | E | W | W | W | W | W | W | W | E | W | E | E | |
| MPH | 8.4 | 8.5 | 8.8 | 9.2 | 8.9 | 8.1 | 6.4 | 5.8 | 6.8 | 7.6 | 8.2 | 8.4 | 7.9 |
| kmph | 13.5 | 13.7 | 14.2 | 14.8 | 14.3 | 13.0 | 10.3 | 9.3 | 10.9 | 12.2 | 13.2 | 13.5 | 12.8 |

## WATER ⚐4

AVERAGE RAINFALL (GAIN)[3] *1990-2020*

| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INCHES | 0.80 | 0.63 | 0.57 | 0.19 | 0.17 | 0.29 | 2.65 | 2.79 | 1.64 | 0.65 | 0.51 | 0.88 | 11.77 |
| mm | 20.3 | 16.0 | 14.5 | 4.8 | 4.3 | 7.4 | 67.3 | 70.9 | 41.7 | 16.5 | 13.0 | 22.4 | 299.0 |

AVERAGE PAN EVAPORATION (POTENTIAL LOSS)[e,6] *1952 - 2005*

| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INCHES | 3.59 | 4.46 | 7.01 | 9.35 | 11.91 | 13.31 | 10.00 | 8.28 | 8.06 | 7.17 | 4.49 | 3.57 | 91.20 |
| mm | 91.2 | 113.3 | 178.1 | 237.5 | 302.5 | 338.1 | 254.0 | 210.3 | 204.7 | 182.1 | 114.0 | 90.7 | 2,316.5 |

WETTEST YEAR'S RAIN[3] 20.33 INCHES | 516 mm | *2019* DRIEST YEAR'S RAIN[3] 5.61 INCHES | 142 mm | *1947*

LONGEST PERIOD WITH NO MEASURABLE PRECIPITATION[7] 119 DAYS: *03/20/1948 - 07/16/1948*

RAINFALL INCOME[f] 4,787 GPCD / 18,121 lpcd

AREA[g,8] 41.69 SQ MILES / 107.9 $km^2$

POPULATION[g,8] 4,880 *2019 (est.)*

UTILITY-WATER USE[9] 150 GPCD / 568 lpcd

HISTORICAL 18 FT | 5.5 m | *1990* DEPTH TO GROUNDWATER[10] 25 FT | 7.6 m | *2019* CURRENT

CURRENT GROUNDWATER EXTRACTION > NATURAL GROUNDWATER RECHARGE[11]

## WATERGY ⚐5

HOMES THAT COULD BE POWERED BY ENERGY USED TO MOVE & TREAT WATER[9,12] 145

## TOTEM SPECIES ⚐6

PLANT: Saguaro Cactus[h,13] MAMMAL: Mexican Long-Tongued Bat[h,14]

FISH: Sonora Sucker[h,14] BIRD: Rufous-Winged Sparrow[h,14] REPTILE: Mexican Garter Snake[h,14]

AMPHIBIAN: Lowland Leopard Frog[h,14] MEGAFAUNA: Mexican Gray Wolf[h,15] Jaguar[h,16]

Available online at HarvestingRainwater.com/one-page-place-assessments

**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 negat to a positive impact on these species and their habitats and ecosystems, on which our quality of life also depends.

## BENSON, AZ 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 0º. 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.** Modeled using NASA's MERRA-2 Modern-Era Retrospective Analysis because the Benson Station was not available for wind speed/direction.

**e.** 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). 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.

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

**g.** City proper

**h.** Latin names of the listed Totem Species are as follows, in italics: Saguaro Cactus = *Carnegiea gigantea* ; Mexican Long-Tongued Bat = *Choeronycteris Mexicana* ; Sonora Sucker = *Catostomus insignis* ; Rufous-winged sparrow = *Peucaea carpalis* ; Mexican Garter Snake = *Thamnophis eques* ; Lowland Leopard Frog = *Lithobates yavapaiensis* ; Mexican Gray Wolf = *Canis lupus bailey* ; Jaguar = Panthera onca

**CREDITS: Brad Lancaster,** Resource concept | **Megan Hartman,** Resource creation | **Matt Lawley,** ResInnate Permaculture, Research

## BENSON, AZ PLACE-ASSESSMENT REFERENCES

**1.** www.suncalc.org/#/31.9194,-110.2551, converted with Creating a One Page Place Assessment PDF, accessed 10/25/2021

**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.** [BENSON 6 SE] (#020683 - COOP), http://scacis.rcc-acis.org/, accessed 10/25/2021

**4.** https://weatherspark.com/y/2840/Average-Weather-in-Benson-Arizona-United-States-Year-Round, accessed 10/26/2021

**5.** https://myforecast.co/bin/climate.m?city=10797&metric=false, accessed 10/26/2021

**6.** [NOGALES 6 N] (#025921 - Coop), https://wrcc.dri.edu/Climate/comp_table_show.php?stype=pan_evap_avg, 10/25/2021

**7.** Number of Consecutive Days Precipitation < 0.01 for [BENSON 6 SE]; scacis.rcc-acis.org, accessed 10/25/2021

**8.** https://en.wikipedia.org/wiki/Benson,_Arizona, accessed 10/26/2021

**9.** http://www.waterenergy.nau.edu/benson.html, accessed 10/26/2021

**10.** https://gisweb.azwater.gov/gwsi/Detail.aspx?SiteID=315505110145101, accessed 10/26/2021

**11.** It's all connected: Study confirms groundwater pumping linked to river, stream depletion, Shar Porier, Herald Review, 8/9/2019, myheraldreview.com/news/cochise_county/it-s-all-connected-study-confirms-groundwater-pumping-linked-to/article_68a13088-b957-11e9-91ca-afe1fc310d1a.html, accessed 10/26/2021

**12.** https://www.electricitylocal.com/states/arizona/, accessed 10/26/2021

**13.** https://www.fs.fed.us/wildflowers/plant-of-the-week/carnegiea_gigantea.shtml, accessed 10/26/2021

**14.** pima.gov/cmo/sdcp/species/fsheets/vuln/llf.htmll, accessed 5/13/2019

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

**16.** "Jaguar Sighted Near Tucson," Jonathan DuHamel, Tucson Citizen, 11/21/2011, tucsoncitizen.com/wryheat/2011/11/21/-