Evaporation (E) from Walker Lake, Nevada

U.S. Geological Survey
Walker River Basin Project

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An Update for the Walker Mediation Group - April 11, 2006

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Overview

- Walker River Basin Study
- Objectives
- E on Walker Lake
  - Measurement
  - Updated value
  - Historic value
  - Other open water
  - Water budget
- Summary

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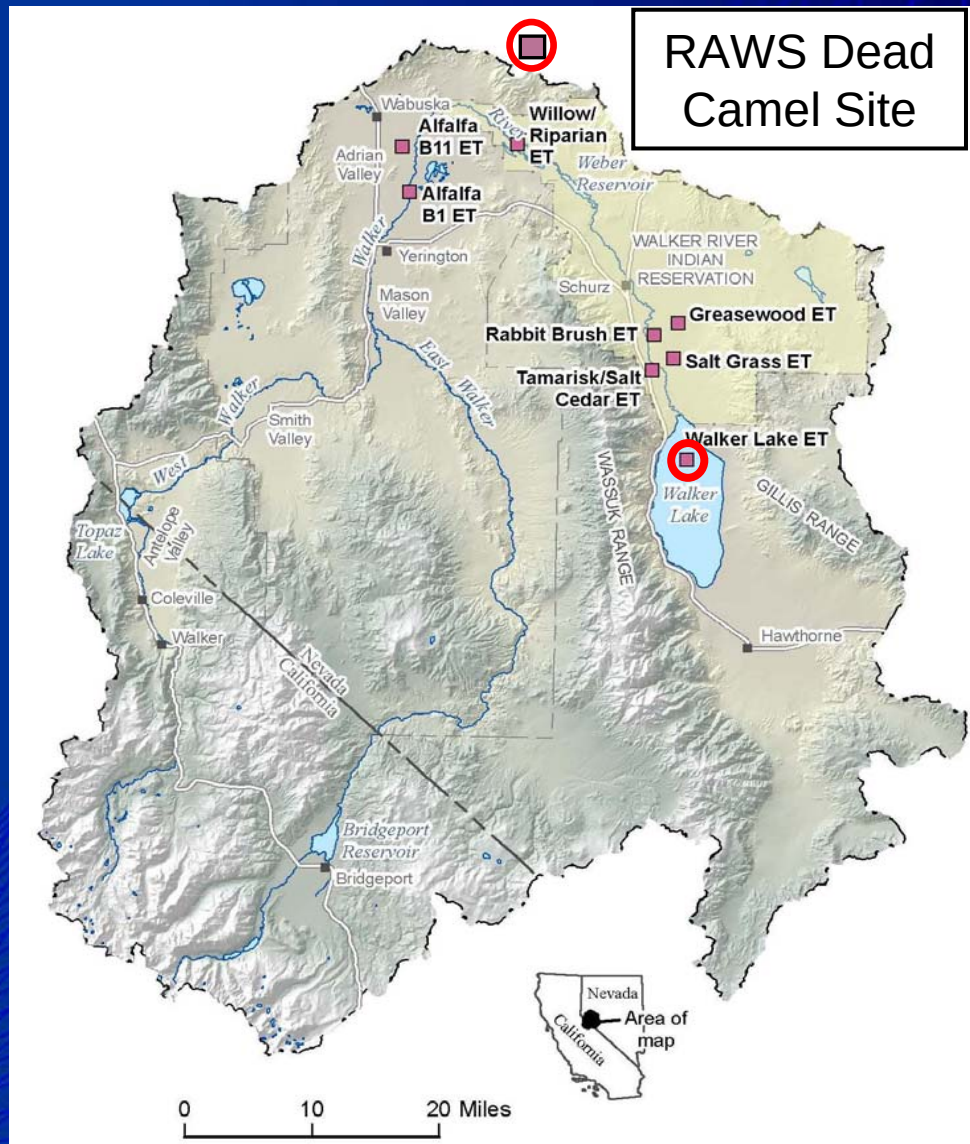
Walker River Basin Project

- In cooperation with Bureau of Reclamation
- Watershed-based understanding of quantity of water and hydrology of basin
- Funding from 2002 Farm Bill
- The project began during the winter of 2004



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Objectives

1) Quantify the volume of natural streamflow in the Basin; determine percentage of streamflow by hydrographic area

2) Determine evapotranspiration (ET) losses from natural and agricultural vegetation and E from open water

3) Develop an improved water budget for Walker Lake

4) Develop capability to predict how changes in upstream water distribution practices will affect streamflow deliveries to Walker Lake

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Measurement of E on Walker Lake

- Installation of floating platform (November 2004)
- Installation of micrometeorologic equipment
- Use of Bowen-ratio energy budget method

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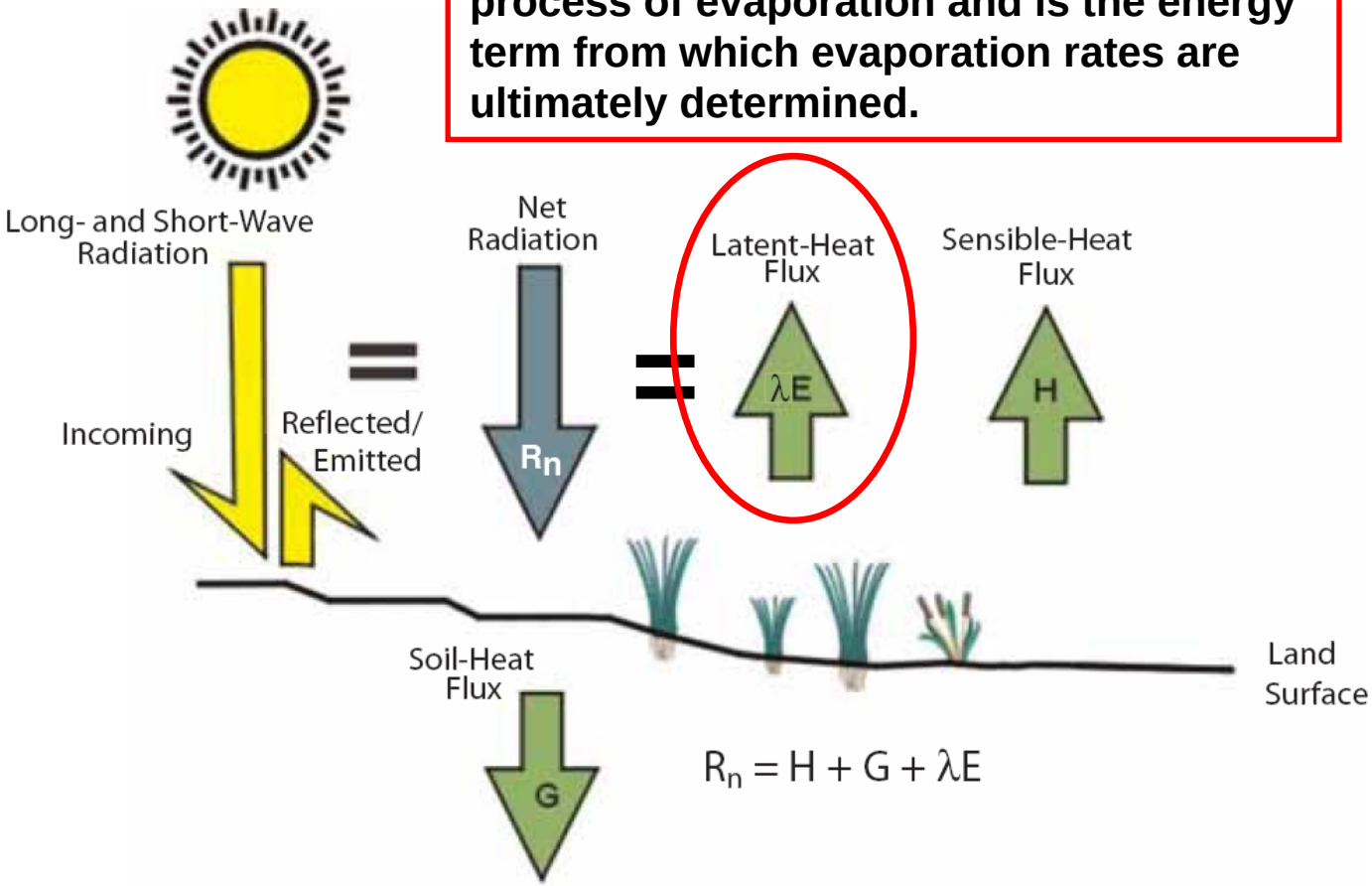
Bowen-ratio energy budget method

This is the energy absorbed by the process of evaporation and is the energy term from which evaporation rates are ultimately determined.



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Results – E from Walker Lake in water year (WY) 2005

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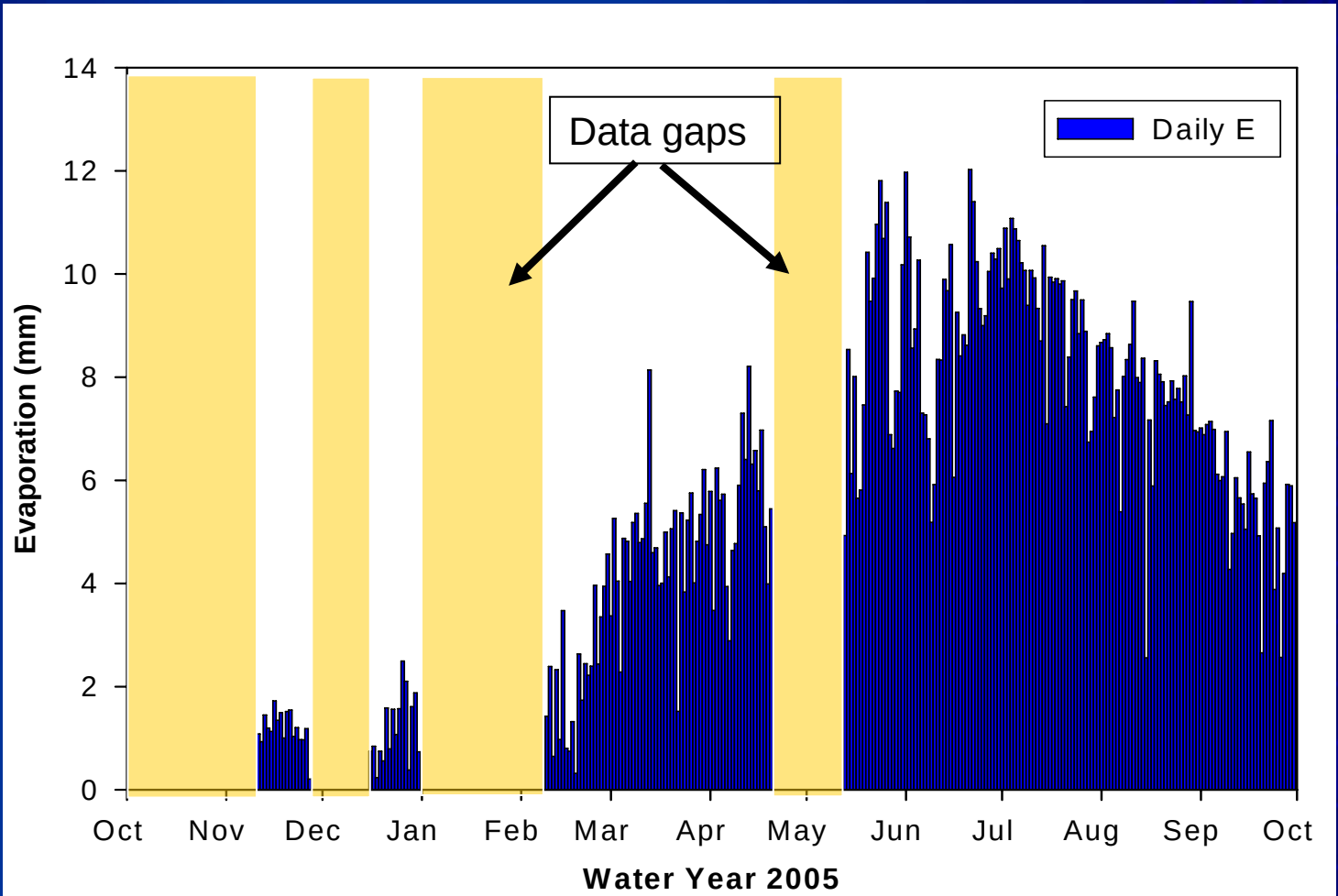
Measured E on Walker Lake



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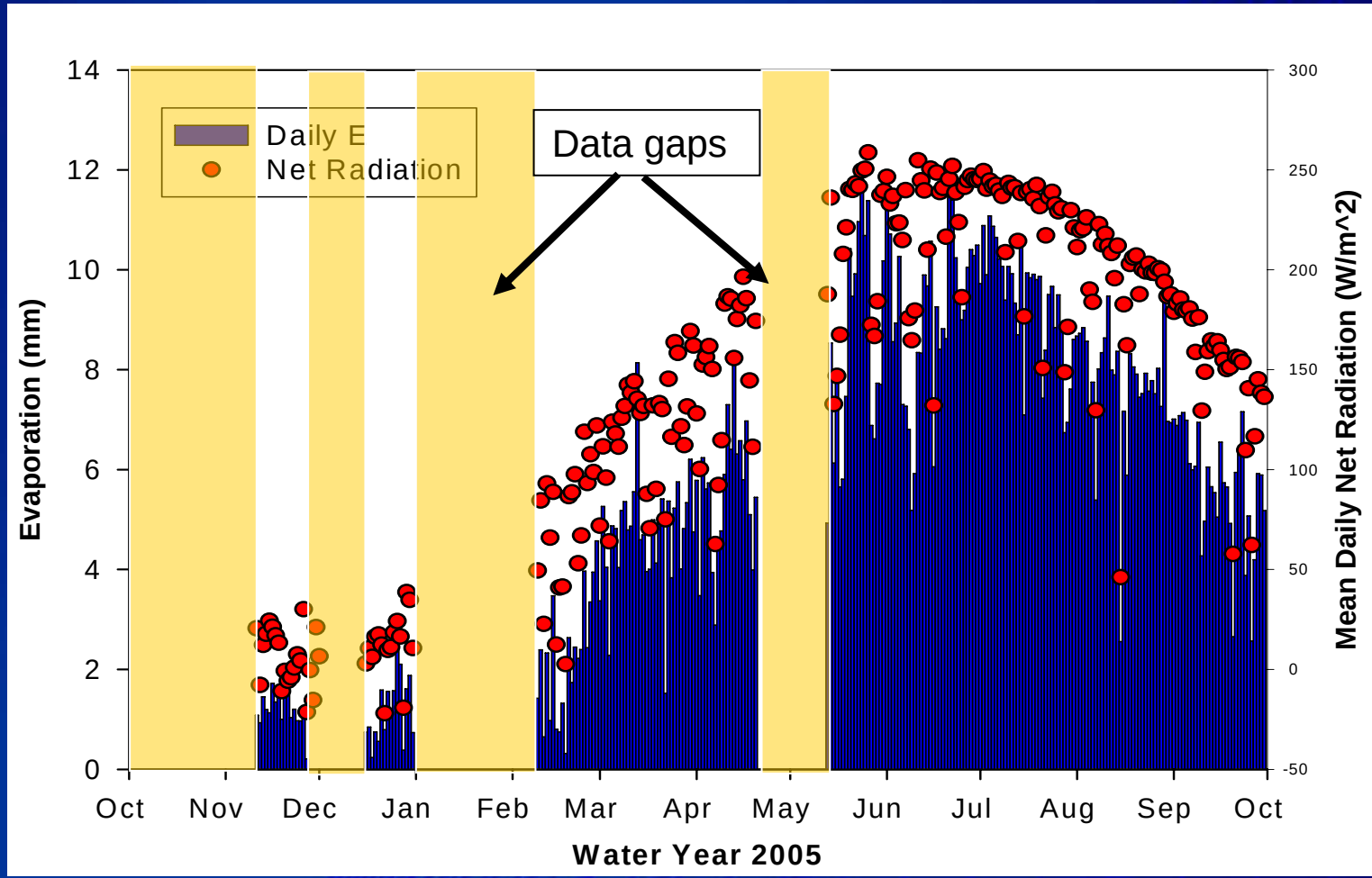
Provisional data has not received final approval and is subject to change with further review

E compared with Net Radiation



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Remote Automated Weather Station (RAWS) – Dead Camel Site

Photo obtained from http://www.wrcc.dri.edu/wraws/pictures/ndea/200509/ndea.ST3.jpg

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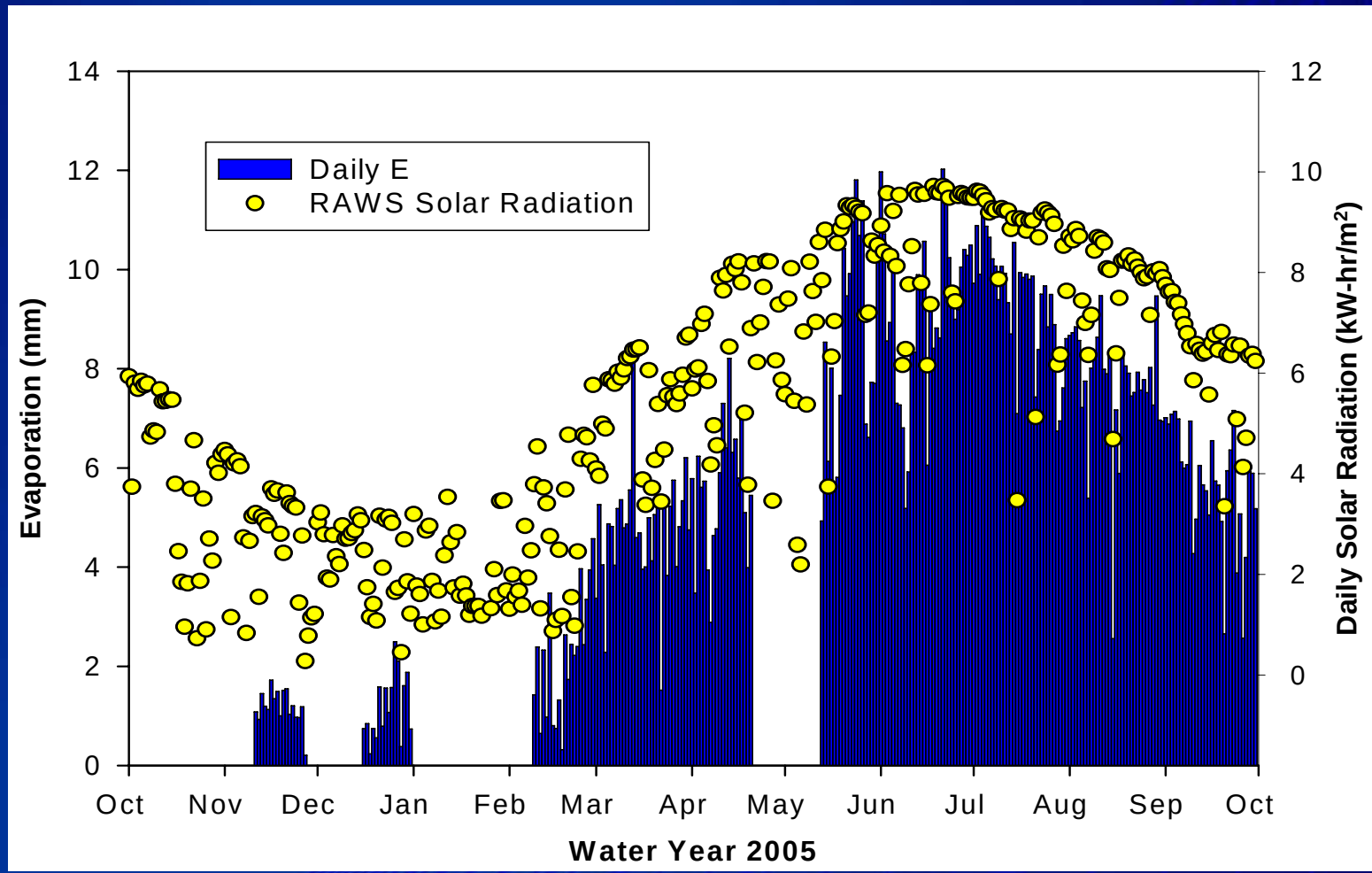
E compared with RAWS Radiation



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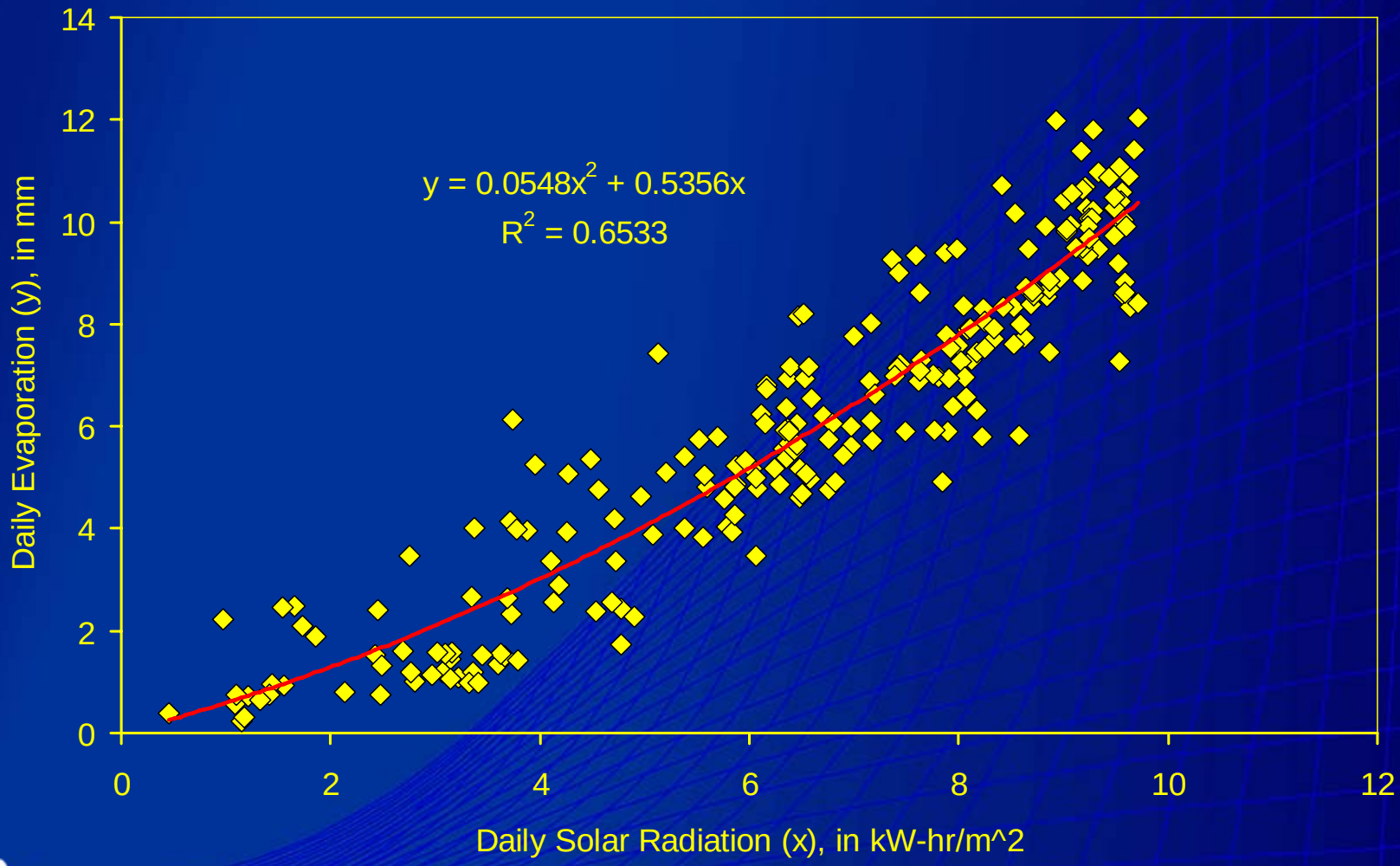
Relation between E and RAWS solar radiation



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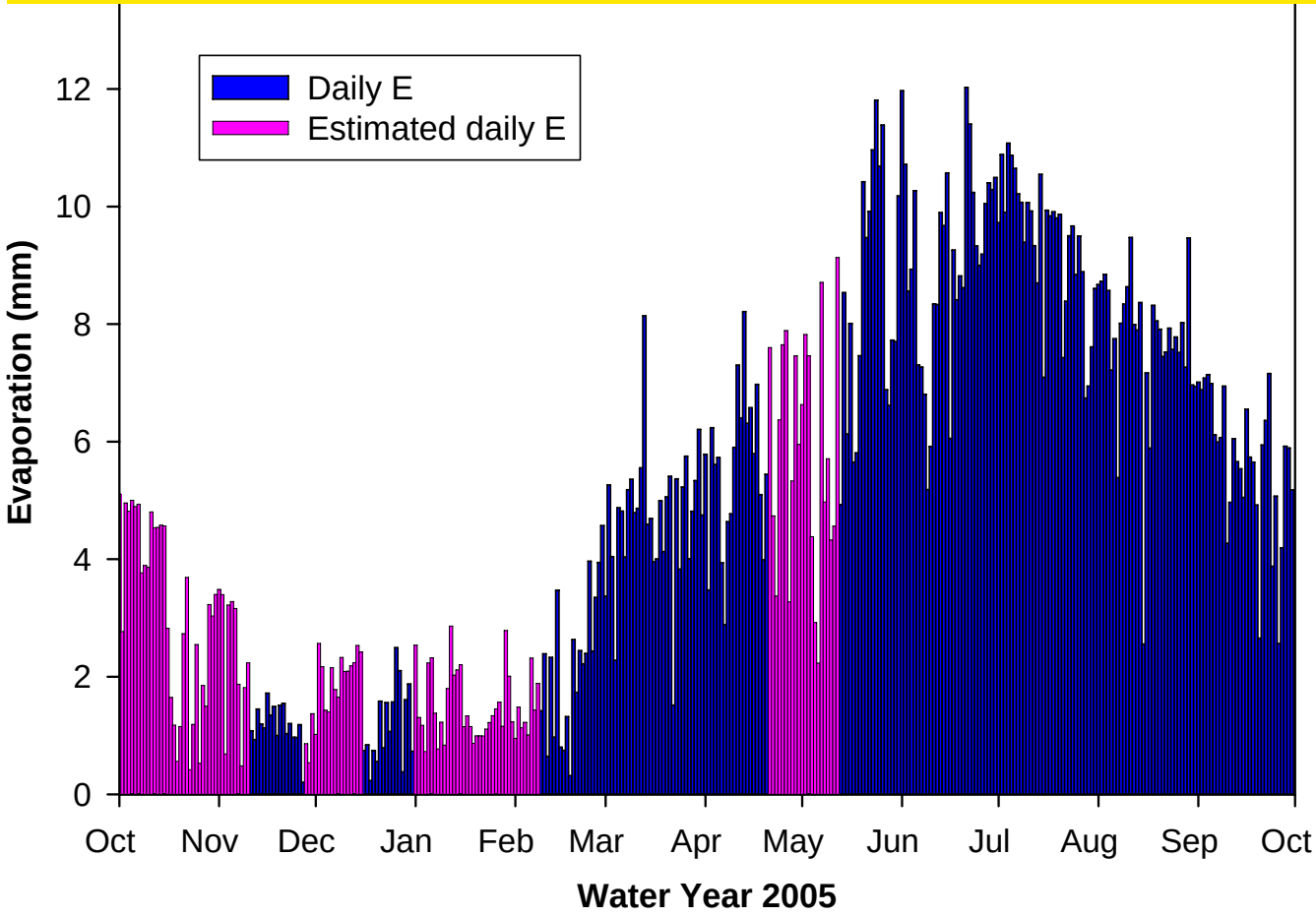
Total E for WY 2005

Total E, WY 2005 = 1,814 mm or 6.0 ft*



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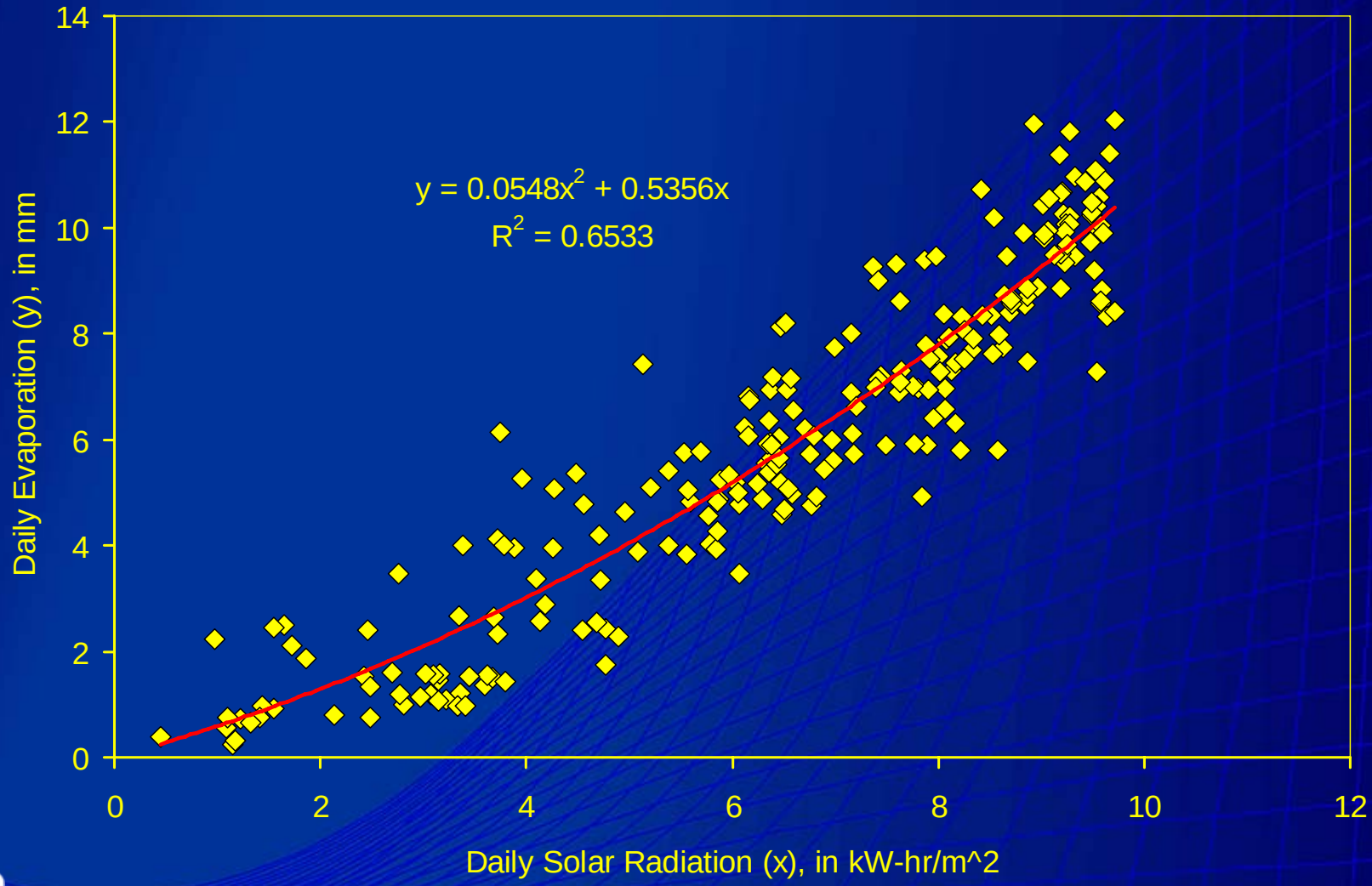
Does this value represent long-term average?



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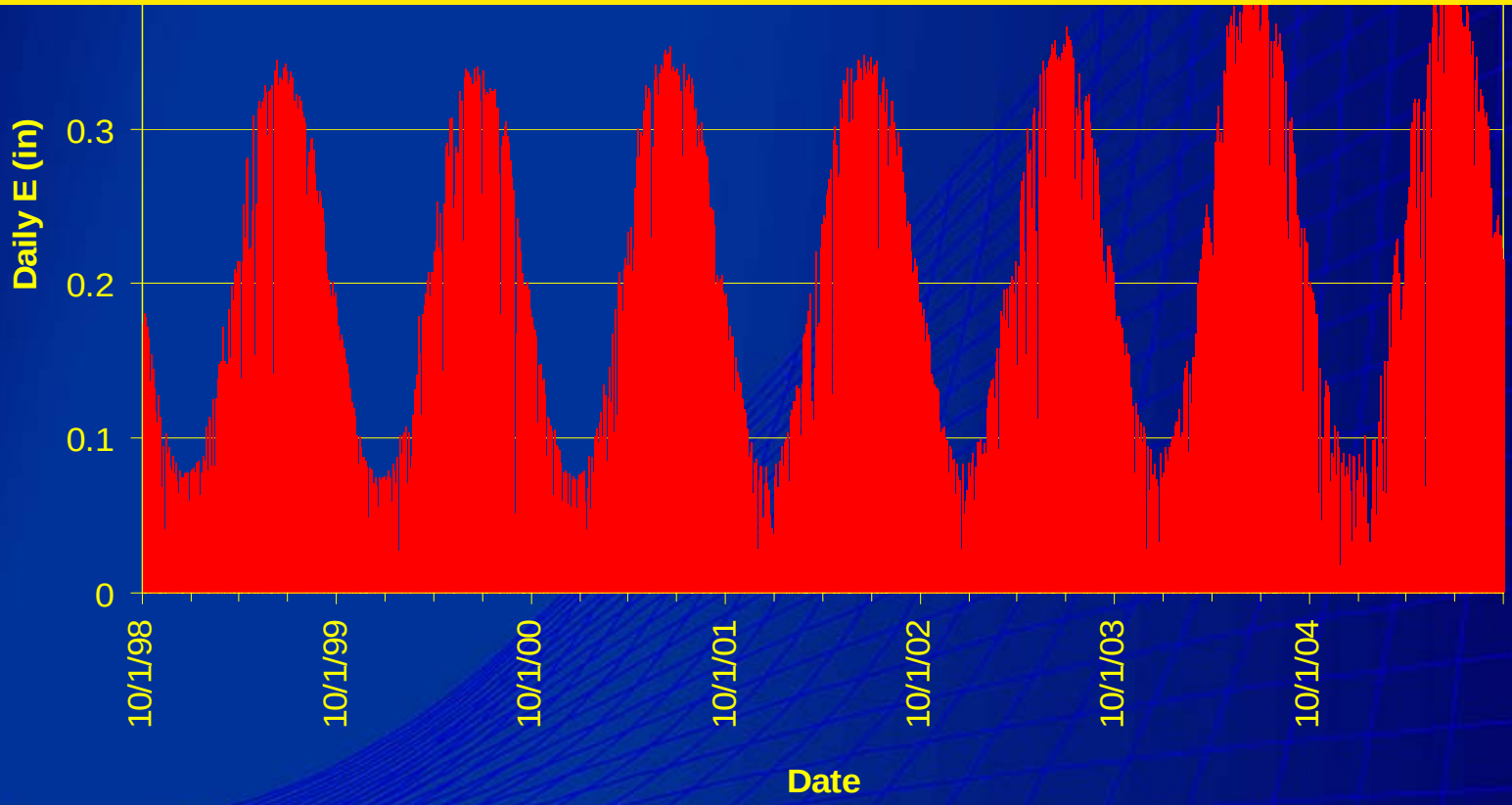
Does this value represent long-term average?

Mean annual E from WY 1999 through WY 2005 is 1,720 mm or 5.6 ft*



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E from Walker Lake

- Preliminary estimate of E for WY 2005 was 6.0 ft*, up from previous estimates of 4.1 ft.
- Average surface area of Walker Lake in WY2005 was 31,840 acres.
- Estimated water volume evaporated from Walker Lake in WY2005 was 191,000 acre-ft*.
- ~ 50% increase over previous estimate.
- If relation between lake E and RAWS solar radiation data holds, may be able to estimate annual E back to 1999 (provisionally is about 5.6 ft/yr*).

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Why is new estimate of E so much greater than old estimate?

- Where does 4.1 ft/yr come from and how was it developed?

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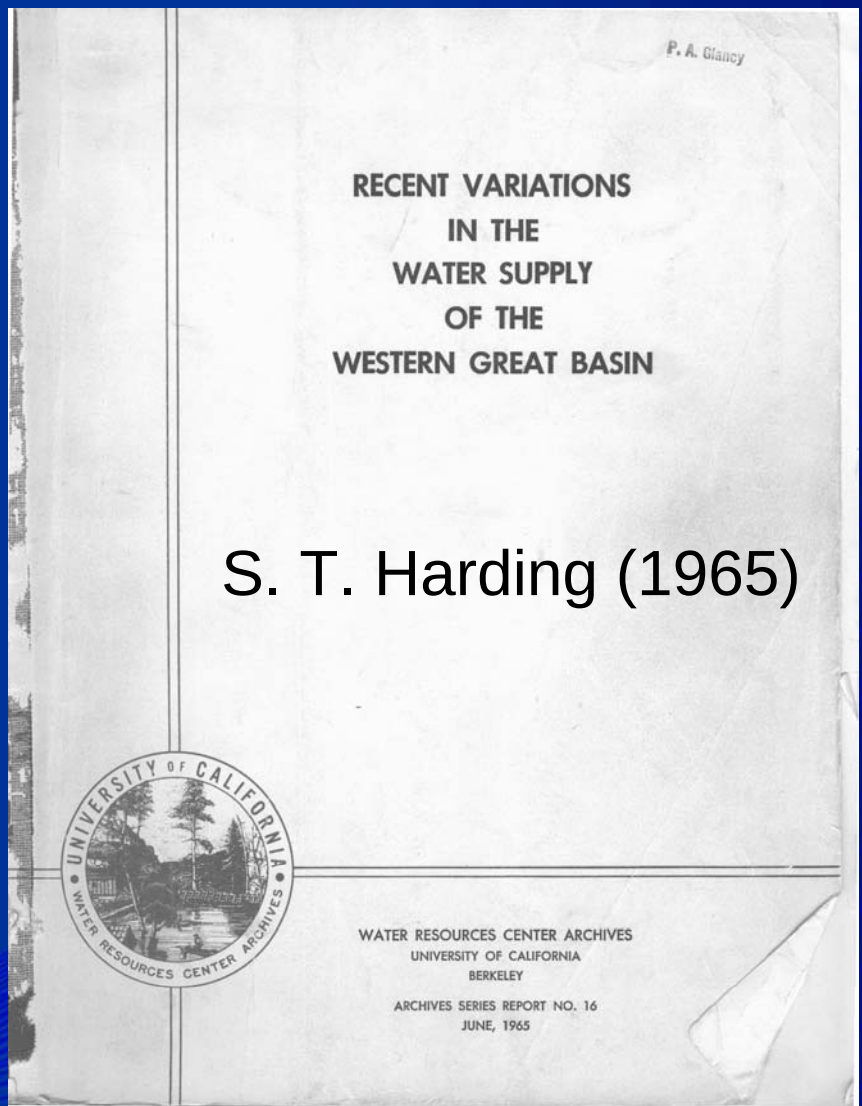
Where is 4.1 ft/yr from?



S. T. Harding (1965)

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Where is 4.1 ft/yr from?

by Capt. J. H. Simpson, 1859). Applying this length to the map prepared by Russell indicates an elevation of Walker Lake in 1845 as shown on Figure 44 or 4035 feet. While the other enclosed lakes in this general area were at relatively low stages in the 1840's it is improbable that Walker Lake rose as much prior to 1861 as would be required to reach the indicated elevation in that year. While Kern traveled the length of the lake his report of its length was not based on a direct measurement. Kern's statement of the width of the lake is much in excess of the actual width.

The mean results derived for the evaporation from Walker Lake have been presented earlier in this report. These are based on the record of inflow from Walker River, precipitation on the Lake based on the records at Schurz and Hawthorne and the fluctuations of the lake. The available records enabled the monthly evaporation to be computed for most of the months from 1928 to 1960 as shown in Table 23. Usable results were obtained for from 16 to 26

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Where is 4.1 ft/yr from?

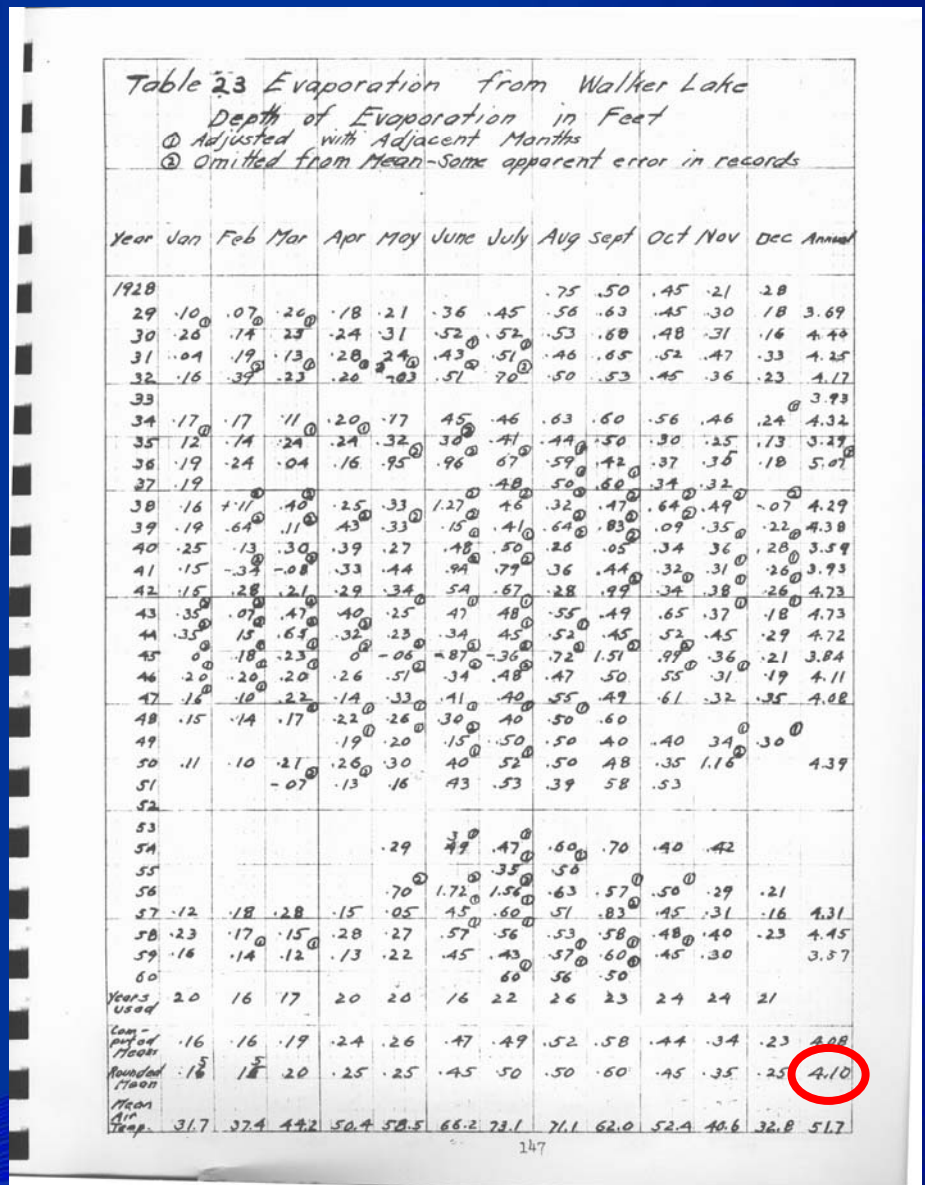

Table 23 Evaporation from Walker Lake

Depth of Evaporation in Feet

① Adjusted with Adjacent Months

② Omitted from Mean-Some apparent error in records

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1928								.75	.50	.45	.21	.28	
29	.10 ①	.07 ②	.26 ①	.18	.21	.36	.45	.56	.63	.45	.30	.18	3.69
30	.26	.14	.23	.24	.31	.52 ①	.52 ②	.53	.68	.48	.31	.16	4.44
31	.04	.19	.13 ①	.28 ②	.24 ①	.43 ②	.51 ①	.46	.65	.52	.47	.33	4.25
32	.16	.39 ②	.23	.20	.03	.51 ②	.70 ①	.50	.53	.45	.36	.23	4.17
33												②	3.93
34	.17 ②	.17	.11 ①	.20 ①	.17	.45 ②	.46	.63	.60	.56	.46	.24	4.32
35	.12	.14	.24	.24	.32 ①	.30 ②	.41 ①	.44 ②	.50	.30	.25	.13	3.29
36	.19	.24	.04	.16	.95 ①	.96 ②	.67 ①	.59 ②	.42 ①	.37	.36	.18	5.07 ②
37	.19	②	②	②	②	②	.48 ①	.50 ②	.60 ①	.34 ②	.32 ①	②	②
38	.16	.11 ①	.40 ①	.25 ②	.33 ①	1.27 ②	.46 ①	.32 ②	.47 ①	.64 ②	.49 ①	.07 ②	4.29
39	.19	.64 ①	.11 ①	.43 ②	.33 ①	.15 ②	.41 ①	.64 ②	.83 ①	.09	.35 ①	.22 ②	4.38
40	.25	.13	.30 ②	.39	.27	.48 ②	.50 ①	.26	.05	.34	.36 ①	.28 ②	3.59
41	.15	.34 ②	.08 ②	.33	.44	.94 ②	.79 ①	.36	.44 ①	.32 ②	.31 ①	.26 ②	3.93
42	.15	.28	.21 ①	.29	.34	.54	.67 ①	.28	.99 ①	.34 ②	.38 ①	.26 ②	4.23
43	.35 ②	.07 ②	.47 ①	.40 ②	.25 ①	.47 ②	.48 ①	.55 ②	.49 ①	.65	.37 ①	.18 ②	4.73
44	.35 ②	.15 ②	.65 ①	.32 ②	.23 ①	.34 ②	.45 ①	.52 ②	.45 ①	.52 ②	.45 ①	.29 ②	4.72
45	0 ②	.18 ②	.23 ①	0 ②	-.06 ①	-.87 ②	-.36 ①	.72 ②	1.51 ①	.99 ②	.36 ①	.21 ②	3.84
46	.20 ②	.20 ②	.20 ①	.26	.51 ①	.34 ②	.48 ①	.47 ②	.50	.55 ②	.31 ①	.19 ②	4.11
47	.16 ②	.10 ②	.22 ①	.14 ②	.33 ①	.41 ②	.40 ①	.55 ②	.49 ①	.61	.32 ①	.35 ②	4.08
48	.15	.14	.17	.22 ②	.26 ①	.30 ②	.40 ①	.50 ②	.60 ①				
49				.19 ②	.20 ①	.15 ②	.50 ①	.50 ②	.40 ①	.40 ②	.34 ①	.30 ②	
50	.11	.10	.21 ②	.26 ②	.30 ①	.40 ②	.52 ①	.50 ②	.48 ①	.35 ②	1.16 ①		4.39
51			-.07 ②	.13	.16 ①	.43 ②	.53 ①	.39 ②	.58 ①	.53 ②			
52													
53													
54					.29 ①	.49 ②	.47 ①	.60 ②	.70 ①	.40 ②	.42 ①		
55							.35 ①	.56 ②					
56					.70 ②	1.72 ②	1.56 ①	.63 ②	.57 ①	.50 ②	.29 ①	.21 ②	
57	.12	.18	.28	.15	.05	.45 ②	.60 ①	.51 ②	.83 ①	.45 ②	.31 ①	.16 ②	4.31
58	.23	.17 ②	.15 ①	.28	.27	.57 ②	.56 ①	.53 ②	.58 ①	.48 ②	.40 ①	.23 ②	4.45
59	.16	.14	.12	.13	.22	.45 ②	.43 ①	.57 ②	.60 ①	.45 ②	.30 ①		3.57
60							.60 ①	.56 ②	.50 ①				
Years used	20	16	17	20	20	16	22	26	23	24	24	21	
Computed Mean	.16	.16	.19	.24	.26	.47	.49	.52	.58	.44	.34	.23	4.08
Rounded Mean	.15	.15	.20	.25	.25	.45	.50	.50	.60	.45	.35	.25	4.10
Mean Air Temp.	31.7	37.4	44.2	50.4	58.5	66.2	73.1	71.1	62.0	52.4	40.6	32.8	51.7

147

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How does Walker Lake E compare with E on other open water in NV?

- Ruby Lake in NE NV, WY 2000: 5.3 ft
  (Berger, D.L., Johnson, M.J., and Tumbusch, M.L., 2001, Estimates of ET from Ruby Lake NWR Area: USGS WRIR 01-4234, p. 16.).

- Peterson Reservoir in S Central NV, WY 1996 & 1997: 8.6 ft
  (Laczniak, R.J. and others, 1999, Estimates of GW discharge determined from measurements of ET, Ash Meadows Area: USGS WRIR 99-4079, p. 31.).

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What are implications to Walker Lake water budget?

- Precip + SW + GW – E = Δ Storage

- Large increase in estimate of E indicates that a greater amount of water is going into Walker Lake than previously estimated.

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Water Budget – 2005 WY

	Component	Lake area (acres)	(ft)	(acre-ft)
Outflow	Evaporation	31,840	6.0	191,000*
Inflow	Walker River			95,000*
	Precip	31,840	0.46	15,000
	Ground water			17,000
	Runoff			3,000
	Total			130,000*
	Inflow-Outflow			-61,000*
Storage Change				-21,000*
Unaccounted Inflow				-40,000*

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Water Budget

- Δ Storage:
  - Recent work by Lopes and Smith (in progress) shows that storage values computed by Rush (1970) are very good.
- SW:
  - SW from Walker River is gaged.
  - SW from Wassuk streams are not gaged and have a variety of estimates.

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Water Budget

- Precip:
  - Is small and is measured on Walker Lake and in Hawthorne. Agreement between the sites are good and therefore estimates of precip are good.

- GW:
  - GW = GW(north) + GW(south) + GW(Wassuk) + GW(Gillis).
  - A very complicated component that isn't well understood.

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Water Budget

- Least known components are SW from the Wassuk and GW inflow.

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Summary

- E is being measured on Walker Lake since November 2004.
- E in WY 2005 was 6.0 ft*.
- Annual E may be less and around 5.6 ft*.
- Previous estimate of E (4.1 ft/yr) did not include local runoff or GW in computation and therefore underestimated annual E.
- New estimate of E compares well with other NV lakes with modern measurements.

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Summary (continued)

- Walker Lake is receiving more water than previously recognized.
- Water budget components of Walker River inflow, direct precipitation, and storage components are good.
- Water budget components of SW inflow from Wassuk and overall GW inflows to Walker Lake are not well understood.

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Questions/Discussion
http://nevada.usgs.gov/walker/
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