Utah State University
DigitalCommons@USU

Progress reports | US/IBP Desert Biome Digital Collection

1975

Measurement of Evapotranspiration with a Monolith Lysimeter

D. W. Young

D. D. Evans

T. W. Sammis

C. Constant

Follow this and additional works at: http://digitalcommons.usu.edu/dbiome_progress

Part of the Natural Resources and Conservation Commons

Recommended Citation

Young, D. W.; Evans, D. D.; Sammis, T. W.; and Constant, C., "Measurement of Evapotranspiration with a Monolith Lysimeter" (1975). *Progress reports.* Paper 49.
http://digitalcommons.usu.edu/dbiome_progress/49

This Article is brought to you for free and open access by the US/IBP Desert Biome Digital Collection at DigitalCommons@USU. It has been accepted for inclusion in Progress reports by an authorized administrator of DigitalCommons@USU. For more information, please contact dylan.burns@usu.edu.

UtahStateUniversity
MERRILL-CAZIER LIBRARY

1975 PROGRESS REPORT
[SUPPLEMENT]

MEASUREMENT OF EVAPOTRANSPIRATION WITH A MONOLITH LYSIMETER

D. W. Young, D. D. Evans (Project Leader),
T. W. Sammis and C. Constant
University of Arizona

US/IBP DESERT BIOME
RESEARCH MEMORANDUM 76-34

in

REPORTS OF 1975 PROGRESS
Volume 3: Process Studies
Abiotic Section, pp. 37-41

1975 Proposal No. 2.3.5.1

Printed 1976

The material contained herein does not constitute publication. It is subject to revision and reinterpretation. The author(s) requests that it not be cited without expressed permission.

Citation format: Author(s). 1976. Title.
US/IBP Desert Biome Res. Memo. 76-34.
Utah State Univ., Logan. 5 pp.

Utah State University is an equal opportunity/affirmative action employer. All educational programs are available to everyone regardless of race, color, religion, sex, age or national origin.

Ecology Center, Utah State University, Logan, Utah 84322

As mentioned in our previous progress report (Young et al. 1975), it was felt that the butyl rubber irrigation tubing which made up the hydraulic transducer package was the "weak link" in the lysimeter design. Construction of the lysimeter was completed in December 1974, and data collection began in January 1975. It became immediately evident that certain inherent design problems existed within the hydraulic transducer package, and the manifold and manometer measuring systems. At first it was believed that the problem was entirely a matter of effects due to extreme temperature fluctuations experienced in the desert biome. Numerous steps were taken in an attempt to dampen out the temperature effects we were experiencing; however, we were still left with a cyclic (sine wave) diurnal output tracing which we were unable to explain. We now feel that the diurnal fluctuations we were recording coincide, in fact, with the normal diurnal sine wave tracings of barometric pressure.

We spent many months attempting to correct this problem, but nothing appeared to alleviate the diurnal tracings we were receiving off the HP 7155A recorder. Due to the extreme sensitivity of the hydraulic transducers, we have estimated that even a very small amount of air, which probably came out of solution upon temperature stabilization of the tubes, could have been responsible for the changes in head due to changes in local barometric pressure.

During an attempt to increase head in the transducer unit, we experienced a blow-out in one of the internal tubes, which caused a back siphonage from the remaining tubes through the connecting manifold. The lysimeter dropped and bottomed out on the transducer support plate, necessitating repairs on the lysimeter.

We had previously been in contact with Transducers, Inc., a California-based electronic strain-gauge manufacturing firm, about the possibility of using such devices if another lysimeter was to be built. Based on their information, it was felt that electronic strain-gauge transducers were a feasible alternative to the hydraulic system. Since our lysimeter had to be pulled and the transducer package replaced, we decided to install the electronic transducers instead of replacing the hydraulic package.

Since several other design modifications were desirable (i.e., additional access ports), and it was questionable whether the 24-ton lysimeter could be successfully lifted out of the hole, we decided to dig up the entire outer cylinder so the lysimeter could be hydraulically jacked up the required distance (Fig. 1). A backhoe was used and the outer cylinder removed in order to gain access to the inner shell. Hydraulic jacks were used to raise the lysimeter approximately 56 cm. The butyl transducers and transducer support plate were removed and forms were set to pour the concrete transducer support pads (91 cm diameter x 45 cm deep; Fig. 2).

It was critical that the electronic transducers be installed within $\pm$ 1% of level to assure their correct operation. Thus, it was important that the concrete support pads be poured and exactly leveled for the transducer bottom support plate. The top support plates had to be leveled and shimmed against their respective eight-inch WF I-beams, which had to be welded to the underside of the lysimeter. After allowing the concrete support pilings to cure, the three electronic transducers were attached to their respective base support plates and the lysimeter was gently lowered onto them (Fig. 3).

Portions of the equipment/instrument well and the outer cylinder were modified to facilitate access to the underside of the lysimeter and the three transducers in case replacement is ever necessary. This was readily accomplished in the field by adding sections of CMP to the existing outer cylinder (Fig. 4) and connecting the instrument well to one of the three access ports corresponding to the three transducer positions (Fig. 5).

After connecting and testing the new transducer package, the lysimeter was backfilled, returned to natural grade and restored, as nearly as possible, to natural conditions. Revised engineering drawings of the modified lysimeter are in Appendix I, Figures 1-3, of this report.

Test data show the modified lysimeter is capable of detecting a change of 0.19 mm of water over its surface area (12.57 m^2) or, in other words, can detect $\pm$ 2.36 kg. The sensitivity is limited by the electronic system. The specification from Transducers, Inc., states that the electronic system is stable at the 1-mv single output level. This is a sensitivity of 0.19 mm of H_2O. In actual field tests the noise level appears to be approximately .2 mv. This results in a sensitivity of detecting a change of 0.04 mm of water. This is considered to be a very realistic, practical sensitivity with a monolith lysimeter.

In addition to the high degree of sensitivity attained, we have also eliminated the differential loading problems which often exist with the multiple hydraulic tube design. Loading can take place virtually at any point, or points, within the surface area of the lysimeter and the integrating circuitry automatically compensates, giving a consistent and exact weight in each case.

The response time calculated with the hydraulic transducers lysimeter was approximately 300 seconds. The response time for the electronic strain gauge transducer lysimeter is instantaneous.

The electronic transducer package is not sensitive to temperature within the range encountered in the field. The hydraulic transducer lysimeter appeared to be highly responsive to temperature changes, and caused real problems when temperatures fell below freezing. Another problem with the hydraulic system is that a very sensitive differential pressure transducer is needed to convert changes in pressure to an electrical output for continuous recording. This instrument is subject to all the inherent problems in electronic stability plus the stability problems of the hydraulic system. Wind set up pressure waves, causing the output from the pressure transducer to be very noisy. Also, it was necessary to constantly change the dummy head to remain within the range of measurement for the pressure transducer.

The only practical problem associated with the electronic strain gauge transducer design is that, at the high gain amplification required by the electronic package, there is a tendency for the 0 output (no-load position) to drift slightly. This introduces error in the reading from one time interval to the next. To correct this problem, you must rezero the output from the electronic system, using a load simulator box (Transducers, Inc.) before each reading.

The biggest advantage of the electronic transducer system over the hydraulic system is that, if any part of the electronic strain gauge system fails for any reason, the individual transducer can be removed from under the lysimeter, using a simple hydraulic jack, and the transducer returned to the factory for repair. In a hydraulic system, if any part of the system fails, the lysimeter becomes inoperable until a large amount of time and money is spent repairing it.

All in all, we definitely feel that the present lysimeter design with the electronic strain gauge transducers is vastly superior to the hydraulic transducer system.

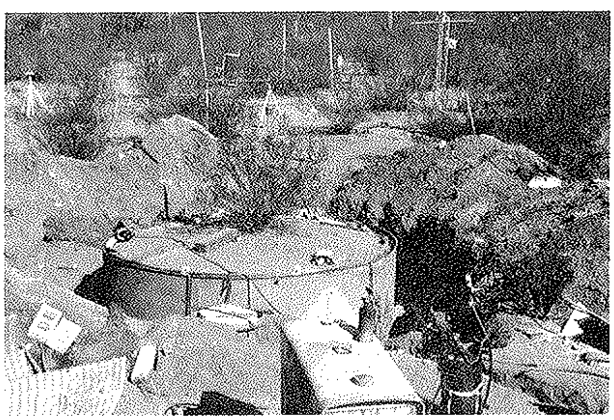


Figure 1. Reexcavation of the monolith lysimeter.

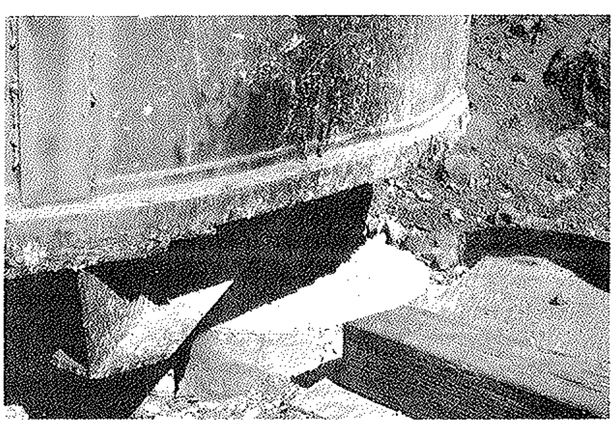


Figure 2. Transducer support pads poured under lysimeter.

LITERATURE CITED

Young, D. W., D. D. Evans, and T. W. Sammis. 1975. Measurement of evapotranspiration with a monolith lysimeter. US/IBP Desert Biome Res. Memo. 75-42. Utah State Univ., Logan. 9 pp.

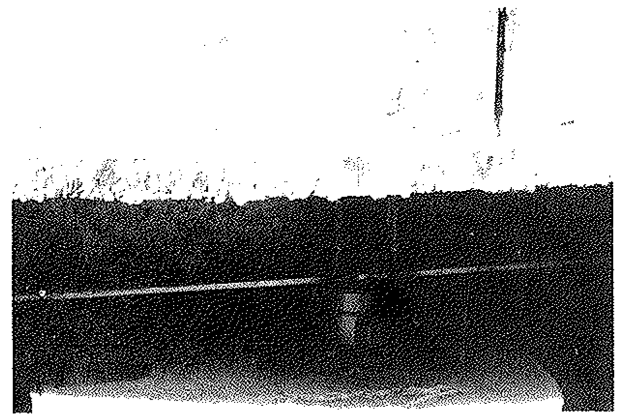


Figure 3. Electronic strain gauge transducer in place under lysimeter.

Figure 4. Access ports added to outer cylinder.

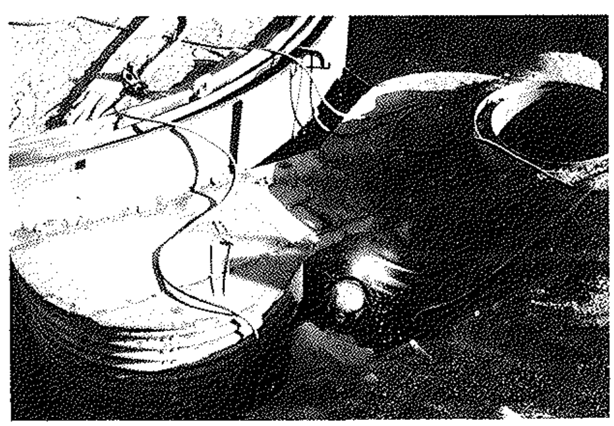
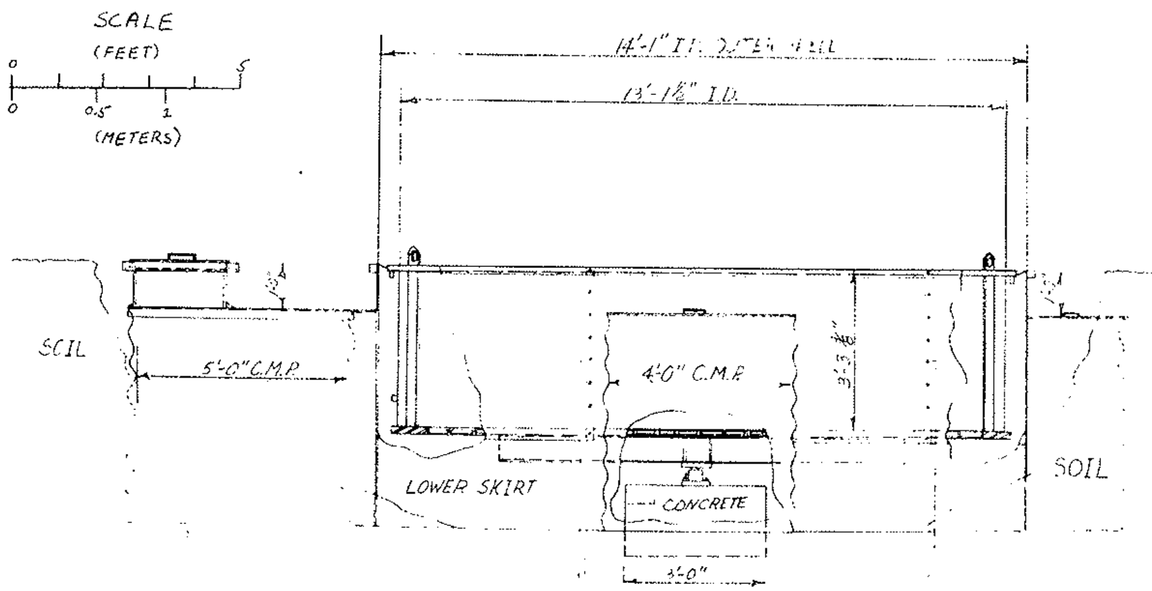
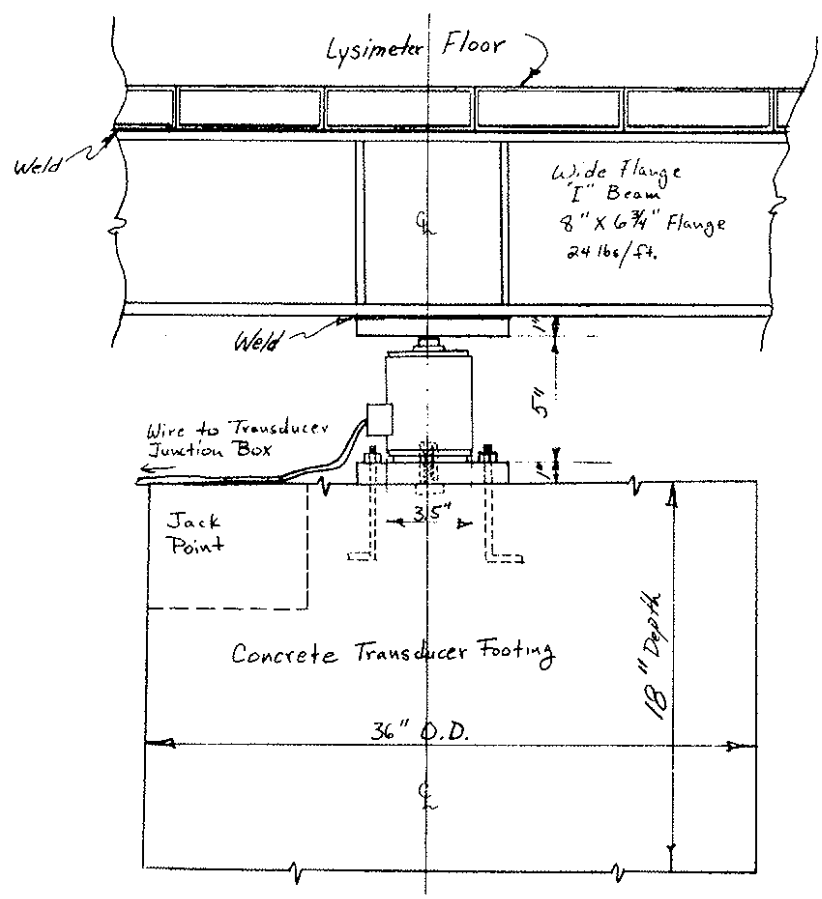


Figure 5. Modifications to equipment/instrument well.

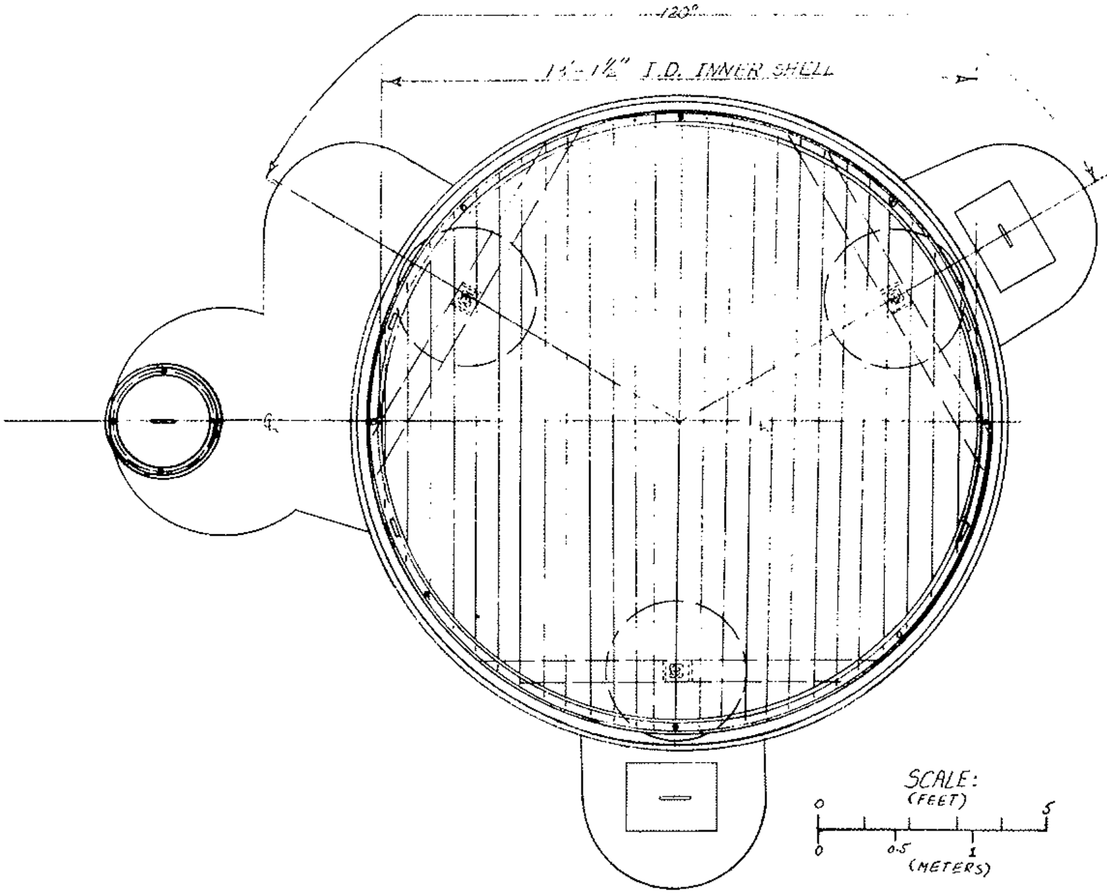
APPENDIX I



Appendix I, Figure 1. Plan view of lysimeter, electronic transducer and access equipment wells.



Appendix I, Figure 2. Plan view of electronic transducer.



Appendix I, Figure 3. A projected view of the lysimeter and equipment wells.