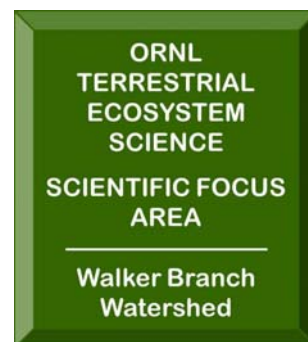


# Walker Branch Watershed: Hourly, Daily, and Annual Precipitation



## Summary:

This data set reports hourly, daily, and annual precipitation in Walker Branch Watershed (WBW). The long-term Walker Branch Hydrology Monitoring project was intended to document changes in the water balance (precipitation inputs, stream discharge outputs) for the WBW over time. This data set contains three data files of precipitation amount for hourly, monthly, and annual intervals for the years 1969 through 2012. Five rain gauges were used from 1969-1979, and two rain gauges were used from 1980-2012.

## Data Citation:

### Cite this data set as follows:

Mulholland, P.J., and N.A. Griffiths. 2016. Walker Branch Watershed: Hourly, Daily, and Annual Precipitation. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tennessee, U.S.A.  
<http://dx.doi.org/10.3334/CDIAC/ornlfsa.006>

### Acknowledgement of Sponsor for Terrestrial Ecosystem Science - Scientific Focus Area (TES SFA):

This research was sponsored by the [Terrestrial Ecosystem Science Program](#), [Office of Biological and Environmental Research](#) within the [U.S. Department of Energy's Office of Science](#).

## Data and Documentation Access:

For public access to WBW data please visit the ORNL TES-SFA Web Site:  
<http://tes-sfa.ornl.gov/>

Walker Branch Watershed website: <http://walkerbranch.ornl.gov/>

Long-term monitoring of WBW is continuing through the National Ecological Observatory Network (NEON), and data are available from the NEON website: <http://www.neonscience.org/>.

### Publications related to this data set:

Curlin, J.W., and D.J. Nelson. 1968. Walker Branch Watershed project: Objectives, facilities, and ecological characteristics. ORNL/TM-2271. Oak Ridge National Laboratory, Oak Ridge, TN.

Luxmoore, R.J. 1983. Water budget of an eastern deciduous forest stand. Soil Science Society of America Journal 47:785-791.

Luxmoore, R.J., and D.D. Huff. 1989. Water. Chapter 5, pages 164-196. In: D.W. Johnson and R.I. Van Hook, eds., Analysis of Biogeochemical Cycling Processes in Walker Branch Watershed. Springer-Verlag, New York.

**Data Policy - Sharing, Access, and Use Recommendations:** ORNL TES-SFA Data Policy - [Data Policy and Fair-Use Statement](#)

**Related Data Sets:** Historical climate, stream discharge, and stream chemistry data are available at <http://tes-sfa.ornl.gov/>. Environmental data from WBW are also available from the NEON website: <http://www.neonscience.org/>.

## **Walker Branch Watershed (WBW) Project Description:**

Walker Branch Watershed (WBW) is a forested watershed on the Oak Ridge Reservation and has been the site of long-term environmental research since the 1960s. Hydrological, biogeochemical, and ecological studies in WBW have made important contributions to our understanding of the effects of changes in atmospheric deposition and climate variability and change in this region (see <http://walkerbranch.ornl.gov/publications.shtml> for complete list of publications).

Objectives of the WBW long-term observations have been to:

1. Quantify responses of an eastern upland oak forest ecosystem to inter-annual and long-term variations in climate and atmospheric deposition of sulfur and nitrogen, and
2. Provide integrated, long-term data on climate, forest vegetation, soil chemistry, and hydrologic and chemical fluxes at the catchment scale to support other focused research projects on the Oak Ridge Reservation and elsewhere in the region.

## **Table of Contents:**

[1 Data Set Overview](#)

[2 Data Characteristics](#)

[3 Applications and Derivation](#)

[4 Quality Assessment](#)

[5 Acquisition Materials and Methods](#)

[6 References](#)

[7 Data Access](#)

## **1. Data Set Overview:**

This data set reports the hourly, daily, and annual precipitation in Walker Branch Watershed from 1969-2012. Over the 43-year measurement period, different rain gauge locations and

models were used, and the instrument names, measurement intervals, and recorder sensitivities are listed (where available) in the Methods section.

## 2. Data Characteristics:

### Spatial Coverage:

This research was conducted in Walker Branch Watershed. There were 5 rain gauges used in this study. Gauges #1, #2, #4, and #5 distributed around the edge of the watershed and #3 on the ridge separating the East and West Fork subcatchments (Fig. 1). When data from WBW rain gauges were not available, precipitation data from nearby rain gauges were reported (Fig. 2).

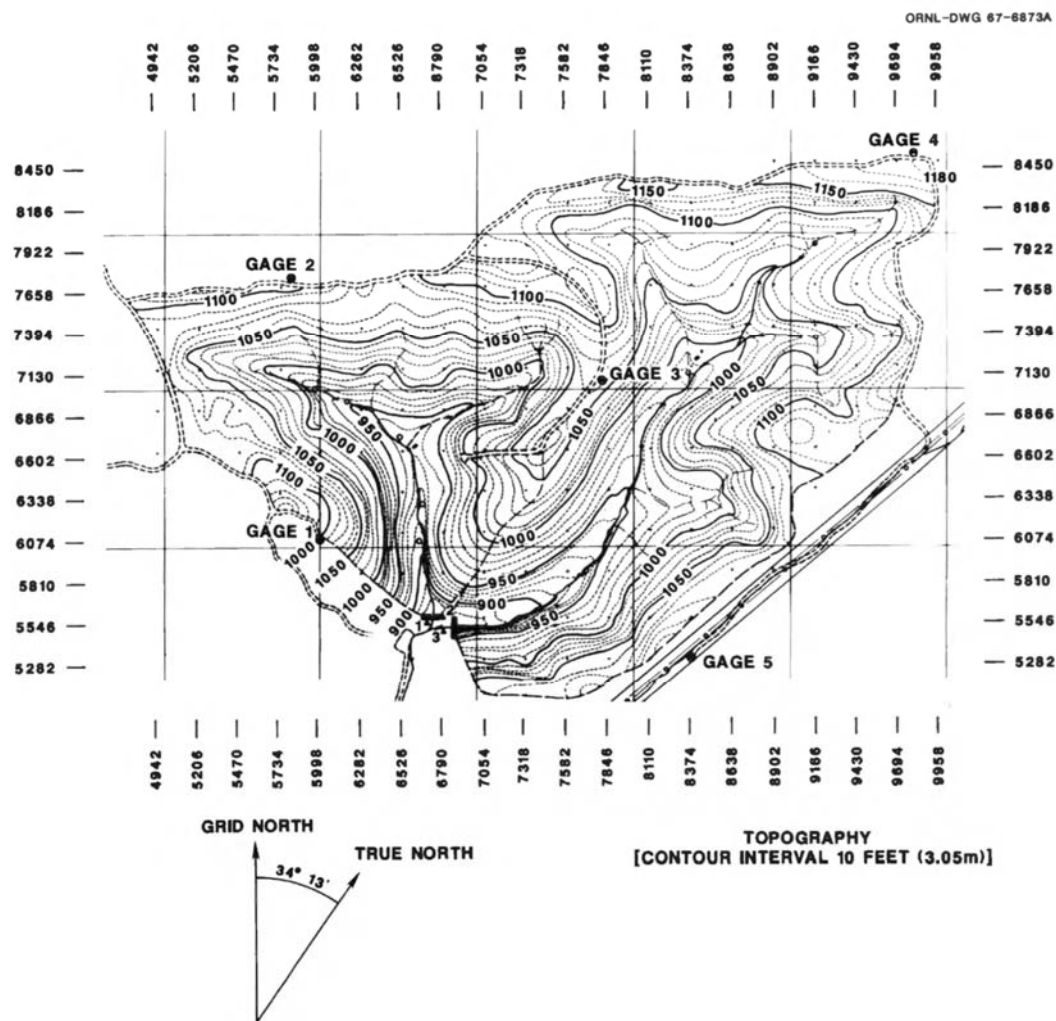


Figure 1 – Topographic map of Walker Branch Watershed showing the locations of the 5 rain gauges (circles). Map is ORNL-DWG-67-6873A.

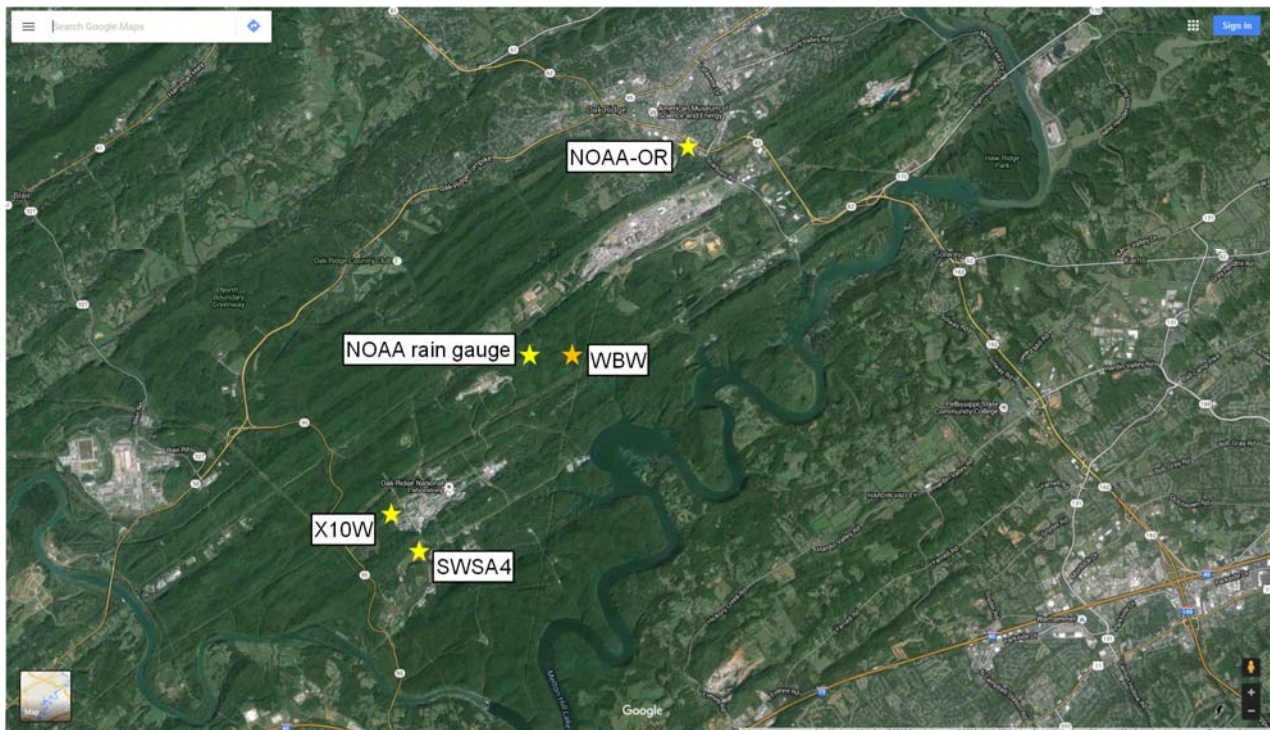


Figure 2 – Google satellite view of the Oak Ridge Reservation, Oak Ridge National Laboratory, and surrounding area. The location of Walker Branch Watershed (WBW) is indicated by an orange star, and the approximate locations of alternative precipitation sites are indicated by yellow stars.

**Site boundaries:** Latitude and longitude given in decimal degrees. Source Google Earth.

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude	Elevation (meters amsl)	Geodetic Datum
West Fork of Walker Branch Watershed	-84.28833	-84.27333	35.97000	35.95833	265	WGS84

**Temporal Coverage:**

**Time period:** The data set covers the period from January 1, 1969 to December 31, 2012.

**Data File Description:**

All of the data are contained in 3 comma separated (\*.csv) files. Missing values are represented by -9999.

- File #1: WBW\_hourly\_precipitation.csv
- File #2: WBW\_daily\_precipitation.csv
- File #3: WBW\_annual\_precipitation.csv

## Data Dictionary:

### File #1: WBW\_hourly\_precipitation.csv

Column	Heading	Units/ Format	Description	Measurement Method
1	DATE	YYYYM MDD	Measurement date.	
2	TIME	HH:MM	Measurement time (EST).	The measurement time indicates the end of the one hour period for which precipitation measurements were collected. For example, precipitation measurements recorded at 16:00 include precipitation that fell from 15:01 to 16:00.
3	PRECIP	mm	Mean total hourly precipitation.	Rain gauge. Mean precipitation was calculated when data from more than one rain gauge was collected.
4	SITE_CODE		Rain gauge ID from where the precipitation data were collected. RG12345 = rain gauge 1-5. NOAAOR = NOAA site in Oak Ridge, TN. RR = unknown (but likely RG1 and 3). X10W = location on west end of Oak Ridge National Laboratory. NOAA-SWSA4 = NOAA rain gauge in WBW or site SWSA4. Whether the data came from the NOAA WBW site or SWSA4 was not distinguished. RG13 = rain gauge 1 and 3. RG1 = rain gauge 1. RG3 = rain gauge 3.	
5	FLAG		'FLAGGED' if data are not reliable.	Data were flagged on 12/30/1972 from 13:00 to 0:00 when there were two measurements reported for the same hour time window.
Historical Walker Branch datasets are available at: <a href="http://tes-sfa.ornl.gov/">http://tes-sfa.ornl.gov/</a> and information about Walker Branch Watershed is available at: <a href="http://walkerbranch.ornl.gov/">http://walkerbranch.ornl.gov/</a> .				
Missing data denoted as '-9999'.				

## Example Data Records:

DATE,TIME,PRECIP,SITE_CODE,FLAG
19690101,1:00,0.0,RG12345,-9999
19690101,2:00,0.0,RG12345,-9999
19690101,3:00,0.0,RG12345,-9999
19690101,4:00,0.0,RG12345,-9999
19690101,5:00,0.0,RG12345,-9999
.....
20121231,20:00,0.0,RG13,-9999
20121231,21:00,0.0,RG13,-9999
20121231,22:00,0.0,RG13,-9999
20121231,23:00,0.0,RG13,-9999
20121231,0:00,0.0,RG13,-9999

**File #2: WBW daily precipitation.csv**

Column	Heading	Units/ Format	Description	Measurement Method
1	DATE	YYYYM MDD	Measurement date.	
2	PRECIP	mm	Total daily precipitation (mean total daily precipitation reported if data were collected at multiple rain gauges).	Rain gauge. Total daily precipitation calculated as the sum of precipitation for a given date.
3	RG1_PRECIP	mm	Total daily precipitation measured at rain gauge 1.	Rain gauge. Total daily precipitation calculated as the sum of precipitation for a given date.
4	RG3_PRECIP	mm	Total daily precipitation measured at rain gauge 3.	Rain gauge. Total daily precipitation calculated as the sum of precipitation for a given date.
5	ALT_PRECIP	mm	Total daily precipitation measured at the alternative rain gauge sites (RR, X10W, NOAAOR, NOAA-SWSA4).	Rain gauge. Total daily precipitation calculated as the sum of precipitation for a given date.
6	SITE_CODE		Location ID from where the precipitation data were collected. RG12345 = rain gauge 1-5. NOAAOR = NOAA site in Oak Ridge, TN. RR = unknown. X10W = location on west end of Oak Ridge National Laboratory. NOAA-SWSA4 = NOAA rain gauge in WBW or site SWSA4. Whether the data came from the NOAA WBW site or SWSA4 was not distinguished RG13 = rain gauge 1 and 3. RG1 = rain gauge 1. RG3 = rain gauge 3.	
Historical Walker Branch datasets are available at: <a href="http://tes-sfa.ornl.gov/">http://tes-sfa.ornl.gov/</a> and information about Walker Branch Watershed is available at: <a href="http://walkerbranch.ornl.gov/">http://walkerbranch.ornl.gov/</a> .				
Missing data denoted as '-9999'.				

**Example Data Records:**

<p>Date,PRECIP,RG1_PRECIP,RG3_PRECIP,ALT_PRECIP,SITE_CODE</p> <p>19690101,0,-9999,-9999,-9999,RG12345</p> <p>19690102,0,-9999,-9999,-9999,RG12345</p> <p>19690103,2.3,-9999,-9999,-9999,RG12345</p> <p>19690104,0,-9999,-9999,-9999,RG12345</p> <p>19690105,0.3,-9999,-9999,-9999,RG12345</p> <p>....</p> <p>20121227,0,0,0,-9999,RG13</p> <p>20121228,2.2,2.2,2.2,-9999,RG13</p> <p>20121229,2,1.9,2.1,-9999,RG13</p> <p>20121230,0,0,0,-9999,RG13</p> <p>20121231,0,0,0,-9999,RG13</p>
--

**File #3 name:** WBW\_annual\_precipitation.csv

Column	Heading	Units/ Format	Description	Measurement Method
1	YEAR	YYYY	Measurement year.	
2	ANN_PRECIP	cm	Total precipitation (in cm) in each year (1969-2012).	Sum of daily total precipitation per year.
Historical Walker Branch datasets are available at: <a href="http://tes-sfa.ornl.gov/">http://tes-sfa.ornl.gov/</a> and information about Walker Branch Watershed is available at: <a href="http://walkerbranch.ornl.gov/">http://walkerbranch.ornl.gov/</a> .				
Missing data denoted as '-9999'.				

**Example Data Records:**

YEAR,ANNUAL_PRECIP
1969,123.3
1970,125.7
1971,137.5
1972,158.2
1973,190.7
....
2008,119.8
2009,159.6
2010,126.1
2011,169.5
2012,130.8

**3. Data Application and Derivation:**

The long-term Walker Branch Hydrology Monitoring project was intended to document changes in the water balance (precipitation inputs, stream discharge outputs) for the Walker Branch Watershed over time. These data were used in various publications on hydrology and biogeochemistry in Walker Branch.

**4. Quality Assessment:**

These data are considered at Level 2. Level 2 indicates that, in addition to the Level 1 checks, the product is a complete, externally consistent data product that has undergone interpretative and diagnostic analyses and can be shared with the public. Level 1 indicates an internally consistent data product that has been subjected to quality checks and data management procedures. Instrument calibrations were carried out following the manufacturer’s instructions and analyses followed published procedures.

**5. Data Acquisition Materials and Methods:**

**Site Description:**

Walker Branch Watershed (WBW) is a 97.5 ha second-growth forest on the U.S. Department of Energy’s Oak Ridge Reservation in east Tennessee, USA. There are two headwaters streams

that drain the watershed: the West Fork drains 38.4 ha and the East Fork drains 59.1 ha (Curlin and Nelson 1968). The watershed is underlain by bedrock (Knox Dolomite) with deep soils, primarily Udisols. Vegetation is primarily oaks (*Quercus prinus*, *Quercus alba*), tulip poplar (*Liriodendron tulipifera*), red maple (*Acer rubrum*), and American beech (*Fagus grandifolia*) (Johnson 1989, Kardol et al. 2010). The climate is typical of the southern Appalachian region, with a mean annual temperature of 14.5°C and mean annual precipitation of 135 cm (Curlin and Nelson 1968, Johnson 1989).

### **Precipitation Measurements:**

Five rain gauges were used from 1969-1979, and two rain gauges were used from 1980-2012. From 1969 to 1979, precipitation data from the 5 gauges were area-weighted to determine hourly, daily, and annual precipitation (Curlin and Nelson 1968). Raw data from the individual rain gauges are not available from 1969 to 1979. From 1980 to 1989, precipitation data were from 2 rain gauges in WBW or from nearby rain gauges. From 1980 to 1982, precipitation data were collected from the National Oceanic and Atmospheric Administration Atmospheric Turbulence and Diffusion Division (NOAA/ATDD) laboratory in the city of Oak Ridge, TN (Fig. 2) (<http://www.atdd.noaa.gov/>). From 1983 to 1987, data were likely recorded from rain gauge 1 and 3 in WBW, although one datasheet lists the location as ‘RR’; this site ID is unknown. From 1988 to 1989, precipitation data were collected from X10W (the west end of Oak Ridge National Laboratory) (Fig. 2). This site is likely Tower “C”. From 1990 to 2012, precipitation data were collected from rain gauge 1 and 3 in WBW. Data are available from the individual rain gauges, and mean precipitation was also calculated when both rain gauges were functional. When precipitation data were not available from 1990 to 2012, data from a NOAA rain gauge in WBW or site SWSA4 (Solid Waste Storage Area 4) were reported (Fig. 2). Whether the data came from the NOAA WBW site or SWSA4 was not distinguished. Hourly data are missing for 1997 and 1998.

### **Sampling and Measurement Information:**

Collection Period: 1969 to 1979.

Instrument: Fisher and Porter model 1548 punched-tape weighing recorder.

Locations: Gauges #1, #2, #4, and #5 distributed around the edge of the watershed and #3 on the ridge separating the East and West Fork subcatchments.

Measurement Interval: 5-min intervals.

Recorder Sensitivity: 2.5 mm.

Collection Period: 1980 to 1982.

Instrument: Unknown.

Locations: NOAAOR (NOAA/ATDD laboratory in Oak Ridge, TN; 8 km from Walker Branch Watershed).

Measurement Interval: Unknown.

Recorder Sensitivity: Unknown.

Collection Period: 1983 to 1998.

Instrument: 8-day weighing bucket strip chart recorder.

Locations: Two ridgetop locations: Gauges #1 and #3.



Measurement Interval: The data were recorded continuously on strip charts and read at hourly intervals. The strip charts were read on a digitizing board.

Recorder Sensitivity: 0.25 mm.

Collection Period: 1999 to 2012.

Instrument: Telog R-2100 electronic tipping bucket recorder.

Locations: Two ridgetop locations: Gauges #1 and #3.

Measurement Interval: Hourly intervals.

Recorder Sensitivity: 0.1 mm.

## **6. References:**

Curlin, J. W., and D. J. Nelson. 1968. Walker Branch Watershed project: objectives, facilities, and ecological characteristics. ORNL-TM-2271. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Johnson, D. W. 1989. Site description. Pages 6-20 *in* D. W. Johnson and R. I. Van Hook (editors). Analysis of biogeochemical cycling processes in Walker Branch Watershed. Springer-Verlag, New York, New York.

Kardol, P., D. E. Todd, P. J. Hanson, and P. J. Mulholland. 2010. Long-term successional forest dynamics: species and community responses to climatic variability. *Journal of Vegetation Science* 21:627-642.

## **7. Data Access:**

This data is available through the Oak Ridge National Laboratory (ORNL) Carbon Dioxide Information Analysis Center (CDIAC)

### **Data Archive Center:**

#### **Contact for Data Center Access Information:**

E-mail: <http://cdiacservices.ornl.gov/feedback.cfm>