An “X” in the box indicates no flood stages were reached in this Hydrologic Service Area (HSA) during the month above.

Two tropical systems affected the HSA this month. The remnants of Tropical Storm Bill brought widespread flooding rains to an already saturated eastern Oklahoma and northwest Arkansas during June 2015. Despite this, several areas still received below normal rainfall for June. Normal rainfall in the month of June ranges from 3.9 inches in McIntosh County to 5.9 inches in Wagoner County. The Ozark region of northwest Arkansas averages 5.1 inches for the month. This report, past E-5 reports, and monthly hydrology and climatology summaries can be found at [http://www.srh.noaa.gov/tsa/?n=hydro-monthly-summary](http://www.srh.noaa.gov/tsa/?n=hydro-monthly-summary).

**Monthly Summary**

Using the radar-derived estimated observed precipitation from the RFCs (Fig. 1a), rainfall totals for June 2015 ranged from around 1.5" to around 10" across eastern OK and northwest AR. The lowest totals occurred in eastern Kay, northern Osage, Le Flore, and Sebastian Counties, while the highest totals affected Creek, Okfuskee, Okmulgee, Pittsburg, and Madison Counties. A large portion of the HSA received 5"-8" of rain this month. Despite the high rainfall totals, several areas recorded below normal rainfall for June (Fig. 1b). Portions of Osage, Kay, Pawnee Counties, far northeast OK, southeast OK, and west central AR got only 25%-90% of the normal June rainfall, while elsewhere, the June rainfall was 125% to around 200% of normal.

Tulsa, OK (TSA): June, 2015 Monthly Observed Precipitation
Valid at 7/1/2015 1200 UTC- Created 7/1/15 13:59 UTC

![Fig. 1a. Estimated Observed Rainfall for June 2015](image-url)
In Tulsa, OK, June 2015 ranked as the 18th warmest June (80.8°F; since records began in 1905) and the 59th wettest June (4.77"; since records began in 1888). Fort Smith, AR had the 14th warmest June (80.8°F, tied 1943, 1933; since records began in 1882) and the 57th driest June (3.13"; since records began in 1882). Fayetteville, AR had the 18th warmest (75.2°F) and the 14th wettest (6.77") June since records began in 1950.

Some of the larger precipitation reports (in inches) for June 2015 included:

- Kingston 2S, AR (coop) 11.62
- Hectorville, OK (meso) 8.90
- Okemah, OK (meso) 8.18
- Sallisaw, OK (meso) 9.18
- McAlester, OK (meso) 9.05
- McAlister, OK (ASOS) 9.05
- Tahlequah, OK (meso) 7.99
- Fort Smith, AR (ASOS) 7.94
- Cookson, OK (meso) 7.94

Some of the lowest precipitation reports (in inches) for June 2015 included:

- Wister, OK (meso) 1.87
- Pawnee, OK (coop) 2.45
- Pawnee, OK (meso) 2.45
- Foraker, OK (meso) 2.45
- Fanshawe, OK (coop) 3.02
- Jay, OK (meso) 3.18
- Fort Smith, AR (ASOS) 3.13
- Spavinaw, OK (coop) 3.00
- Spavinaw, OK (coop) 3.00
- Fanshawe, OK (coop) 3.02

According to statistics from the Oklahoma Climatological Survey (OCS) Mesonet:

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<td>2nd wettest</td>
<td>2nd wettest</td>
<td>5th wettest</td>
<td>6th wettest</td>
</tr>
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Daily Temperature Data – Fort Smith Area, AR (ThreadEx)


Accumulated Precipitation – Fort Smith Area, AR (ThreadEx)

Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values.
According to the U.S. Drought Monitor (USDM) from June 30, 2015 (Figs 2, 3), drought free conditions continued across eastern Oklahoma and northwest Arkansas.

**Fig. 2. Drought Monitor for Oklahoma**

**Fig. 3. Drought Monitor for Arkansas**
Reservoirs

According to the USACE, all of the major reservoirs in the HSA were operating well into their flood pools as of 6/30/2015, except for Skiatook Lake, which was at 93% of its conservation pool (but up from 53% at the end up April). The following lakes were operating in their flood control pools (percentage of flood pool listed) as of 6/30/15: Hugo Lake 93%, Sardis Lake 92%, Beaver Lake 89%, Eufaula Lake 86%, Tenkiller Lake 49%, Kaw Lake 45%, Hulah Lake 43%, Ft. Gibson Lake 43%, Grand/Pensacola Lake 42%, Hudson Lake 42%, Wister Lake 41%, Keystone Lake 41%, Oologah Lake 41%, Copan Lake 40%, Birch Lake 31%.

Oklahoma Surface Water Resources
Reservoir Levels and Storage as of 6/29/2015

Outlooks

The Climate Prediction Center (CPC) outlook for July 2015 (issued June 30, 2015) indicates an enhanced chance for below normal temperatures and above median rainfall across all of eastern OK and northwest AR. This outlook is based substantially on information from the short-term forecast for the first half of July. The overall expected weather pattern during this time is a ridge over western North America with a downstream trough near the east coast of the U.S. Some models indicate this pattern will persist through the remainder of July, while others show this pattern breaking down.

For the 3-month period July-August-September 2015, CPC is forecasting an enhanced chance for below normal temperatures and a slightly enhanced chance for above median precipitation across all of eastern OK and northwest AR (outlook issued June 18, 2015). According to CPC, El Niño conditions continue to strengthen and are currently of moderate strength. The coupling between the ocean and atmosphere remains strong over the tropical Pacific. A moderate to strong El Niño is forecast to persist into early 2016. However, El Niño impacts are generally most significant in the Southern Plains during the cold seasons. Therefore, this outlook is based primarily on both statistical and dynamical forecast tools, but does consider El Niño conditions and possible impacts.
**Summary of Precipitation Events** Daily quality controlled rainfall maps can be found at: [http://water.weather.gov/precip/index.php?location_type=wfo&location_name=tsa](http://water.weather.gov/precip/index.php?location_type=wfo&location_name=tsa)

**June 1-16**

After the May inundation, eastern OK and northwest AR had a short reprieve from the rain. But, the first rounds of rain in June came from two mid-level lows interacting with a stalled front and tropical moisture from both the Gulf of Mexico and the remnants of hurricane Blanco from the Pacific. A few showers and thunderstorms occurred during the morning of the 12th as a dying MCS moved into portions of eastern OK. However, the more significant rain occurred during the evening, through the overnight, and into the morning hours as storms trained along the stationary front and dumped 1.5” to near 6” of rain north of I-44 (Fig. 4). During the day on the 13th, an MCV moved northeast across the area, helping to generate showers and thunderstorms during the afternoon and evening hours. Rainfall amounts were generally around 0.25”-1.25”, with isolated totals of 1.5”-3” (Fig. 5). This heavy rain led to rises along the rivers and creeks across northeast OK. Moderate flooding occurred along the Neosho River near Miami and several other rivers approached, but remained just below, flood stage (see the E3 report and preliminary hydrographs at the end of the report).

![Fig. 4. 24-hr Estimated Observed Rainfall ending at 7am CDT 6/13/2015.](image)
The atmosphere then became increasingly more tropical from the Gulf of Mexico. Widespread rain developed over the HSA as a series of mid-level shortwaves passed, despite a lack of synoptic low-level forcing. The majority of eastern OK and northwest AR received some rain on the 14th, though totals remained mostly around 0.50” or less. A few spots received around 1”-1.5”, with far eastern Madison County getting 1.5”-2.5”. A weak shear axis set up over the area on the 15th, with widespread rain once again occurring. The majority of the heaviest rain fell near and south of I-44 and north of a McAlester to Fort Smith line (Fig. 6). Most locations received 0.50”-1.5”, though isolated areas had totals of 1.5”-3.5”. This activity continued through the 16th, bringing an additional 0.25” to 2” of rain (Fig. 7). Flash flooding occurred again with this activity. In Okmulgee County, roads that had been repaired from the May flooding were once again washed away or damaged.
June 17-30

The remnants of Tropical Storm Bill moved north out of the Gulf of Mexico, across central TX, and into south central OK on the 17th. The tropical system then slowed and began moving northeast across the HSA late on the 17th and through the 18th. The center of the remnants moved from south central OK to near McAlester by late morning on the 18th (Figs. 8, 9). The storm then travelled along a path from there to near Stigler, to Fort Smith, to southern Madison County through the remainder of the 18th. Feeder bands of heavy rain occurred ahead of the circulation center, while the highest rainfall totals occurred near the path of the center. Abnormally high atmospheric moisture, near record high precipitable water for June (Fig. 14), made the system very efficient at making rain, with amounts of 2” to 5” across a large area of eastern OK and northwest AR. The highest totals of 5”-12” occurred from south central OK up through portions of northeast and east central OK and into northwest AR (Figs. 10-13). Portions of southeast OK, including Le Flore County, as well as portions of west central AR and Osage and Pawnee Counties received the least amount of rain, generally less than 2”.

With nearly saturated soils from the excessive rainfall and flooding in May, as well as the heavy rain a few days prior, much of the rain became runoff and resulted in flash flooding and river flooding. Several high water rescues were reported in Tulsa County. There were also widespread reports of high water making roads impassable throughout eastern OK. There were 13 river forecast points that went into flood, two of which crested in Major Flood, 3 crested in Moderate Flood, and 8 crested in Minor Flood. Major flooding occurred along the Deep Fork River near Beggs and along the Red River near Arthur City. Preliminary hydrographs are available at the end of this report, and specific river flood information is available in the E3 report. Most of the large reservoirs were still at 50%-70% of their flood pools prior to Bill’s rains, with Sardis and Hugo Lakes at 88% and 94% of their flood pools respectively. Sardis (101%), Hugo (101%), and Eufaula (107%) Lakes exceeded the top of their flood pools from this additional rainfall.

Some of the larger precipitation reports (in inches) for “Bill” – 48hr total ending 7am CDT 6/18/15 included:

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<td>Glenpool 0.6S, OK</td>
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Some of the larger precipitation reports (in inches) for “Bill” – 24hr total ending 7am CDT 6/17/15 included:

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<tr>
<td>Viney Grove 2.4NW, OK</td>
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Fig. 8. Radar images of “Bill” in central TX valid at 11:28am CDT 6/17/2015 (left) and at 1:08pm CDT 6/18/2015 (right).

Fig. 9. Surface analysis as “Bill” moved across HSA, left-to-right: 10pm CDT 6/17; 10am CDT 6/18; 4pm CDT 6/18; 1am CDT 6/19/15.
Fig. 10. 24-hr Estimated Observed Rainfall ending at 7am CDT 6/18/2015.

Fig. 11. 24-hr Estimated Observed Rainfall ending at 7am CDT 6/19/2015.
Fig. 12. 7-day Estimated Observed Rainfall (Image, NWS) and measurements (OK Mesonet) ending at 9:25am CDT 6/22/2015.

Fig. 13. 10-day Estimated Observed Rainfall (Image, NWS) and measurements (OK Mesonet) ending at 9:25am CDT 6/22/2015.
Rain fell along the Red River on the 21st, bringing 0.50”-0.75” of additional rain to southern Choctaw County. However, a nearly stationary storm brought a small area of 3”-7” of rain to south central OK, just east of I-35. This water then flowed downstream, causing the Red River at Arthur City to crest a couple feet higher than the crest expected from “Bill’s” rains alone.

After several days of hot and humid conditions, a cold front moved through the HSA on the 26th. The front brought cooler temperatures, as well as rain. Storms initially affected northeast OK and northwest AR during the morning. Redevelopment occurred ahead of the front by early afternoon, while stronger scattered thunderstorms developed along the outflow generated by the morning convection. The activity exited the HSA by the late night hours. Most of the areas affected by rain received around 0.50” or less. However, portions of east central and southeast OK and northwest AR got 0.50” to around 2” of rain. The highest totals were over Washington Co. AR, where rain totaled 1.5” to around 3” (Fig. 15). Most of this rain fell in the Illinois River basin, causing the Illinois River near Tahlequah to rise above Action Stage but remain below flood stage. Flash flooding was also reported in Washington Co. AR.

Fig. 14. Precipitable water climatology for Norman, OK, with grey circle showing the measured value on 6/17/2015.
A couple of isolated severe thunderstorms developed along a quasi-stationary front during the evening of the 29th, affecting southern Pittsburg and northeast Pushmataha Counties in southeast OK. These storms not only brought 1.5"-3.5" of rain to a small area, but also large hail. Tennis ball-sized hail was reported near Kiowa.

Written by:
Nicole McGavock
Service Hydrologist
WFO Tulsa

Products issued in June 2015:
*MLBA4 and OZGA4 transferred to NWS Tulsa HSA February 5, 2014
*Mixed case River Flood products began July 31, 2013

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Preliminary Hydrographs:

**NEOSHO RIVER NEAR COMMERCE**

Universal Time (UTC)

Latest observed value: 13.39 ft at 10:30 AM CDT 15-Jun-2015. Flood Stage is 15 ft

Moderate: 18.0'
Minor: 15.0'
Action: 14.0'

Site Time (CDT)

Graph Created (10:49AM Jun 15, 2015)  Observed  Forecast (issued 9:00AM Jun 15)

COMC2(plotting HGIS) "Gage 0" Datum: 748.97'  Observations courtesy of US Geological Survey
VERDIGRIS RIVER NEAR LENAPAH

Universal Time (UTC)

Site Time (CDT)

Latest observed value: 21.37 ft at 8:30 AM CDT 16-Jun-2015. Flood Stage is 30 ft.

Moderate: 32.0'  
Minor: 30.0'  
29.15 ft

Flow (cfs)

LEPO2(plotting HGIRG) "Gage 0" Datum: 644.9'  
Observations courtesy of US Geological Survey

ARKANSAS RIVER NEAR MUSKOGEE

Universal Time (UTC)

Site Time (CDT)

Latest observed value: 25.89 ft at 8:00 AM CDT 22-Jun-2015. Flood Stage is 28 ft.

Moderate: 32.0'  
Minor: 28.0'  
28.84 ft

Flow (cfs)

MKGC2(plotting HGIRG) "Gage 0" Datum: 471.38'  
Observations courtesy of US Geological Survey
**SPRING RIVER NEAR QUAPAW**

Latest observed value: 9.61 ft at 8:00 AM CDT 22-Jun-2015. Flood Stage is 20 ft.

**CANEY RIVER NEAR COLLINSVILLE**

Latest observed value: 25.31 ft at 2:30 PM CDT 19-Jun-2015. Flood Stage is 26 ft.

ARKANSAS RIVER AT OZARK L/D TAILWATER

Universal Time (UTC)

Tailwater (ft)

Latest observed value: 355.04 ft at 8:00 AM CDT 29-Jun-2015. Flood Stage is 357 ft

Site Time (CDT)

OZGA4(pplotting HTIRG) "Gage 0" Datum: 0'  Observations courtesy of US Army Corps of Engineers - LRD

EASTERN OKLAHOMA LAKES AT SARDIS LAKE

Universal Time (UTC)

Pool (ft)

Latest observed value: 606.92 ft at 8:00 AM CDT 22-Jun-2015. Flood Stage is 607 ft

Site Time (CDT)

CYD02(pplotting HPFRG) "Gage 0" Datum: 0'  Observations courtesy of US Army Corps of Engineers
**EASTERN OKLAHOMA LAKES AT HUGO LAKE**

Universal Time (UTC)

![Graph showing water levels over time, with the latest observed value of 436.47 ft at 8:00 AM CDT 22-Jun-2015. Flood Stage is 437.5 ft.](image1)

Site Time (CDT)

- Graph Created (8:50AM Jun 22, 2015) — Observed

HGLO2(plotting HPIRG) "Gage 0" Datum: 0’ Observations courtesy of US Army Corps of Engineers

**NORTHWEST ARKANSAS LAKES AT BEAVER LAKE**

Universal Time (UTC)

![Graph showing water levels over time, with the latest observed value of 1129.19 ft at 8:00 AM CDT 22-Jun-2015. Flood Stage is 1130 ft.](image2)

Site Time (CDT)

- Graph Created (8:49AM Jun 22, 2015) — Observed

BVGA4(plotting HPIRG) "Gage 0" Datum: n/a Observations courtesy of US Army Corps of Engineers
Latest observed value: 596.12 ft at 7:01 AM CDT 29-Jun-2015. Flood Stage is 597 ft

Site Time (CDT)

Graph Created (8:19AM Jun 29, 2015)  Observed

EUFO2(plotting HPRG) "Gage 0" Datum: 0"

Observations courtesy of US Army Corps of Engineers