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**THE 1997 SOUTH CENTRAL MONTANA FLOOD SEASON:
A RECORD SETTER**

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Introduction

From late May through late June 1997, Livingston, in south central Montana, had one of the most damaging floods in the history of the region. Livingston, located in Park County, east of the Continental Divide, is about 25 miles east of Bozeman, Montana and about 115 miles west of Billings, Montana. NWSO Billings has hydrologic responsibility for Livingston. This paper will examine the antecedent conditions leading up to the event, the weather during the event, the damages incurred as a result of the flooding in Livingston and nearby communities, and what NWSO Billings did to inform local communities of the impending spring season flood potential.

Antecedent Conditions

The antecedent conditions must be considered in determining flood potential and the need for appropriate watches and warnings. These conditions include the following:

- * The degree of foliation;
- * The river channel's current base flow;
- * The basin's topography;
- * The amount of snowpack in the surrounding mountains; and
- * Existing soil conditions

Antecedent conditions were favorable to cause the record and near record flooding in Livingston and surrounding near-by communities:

- * Snowpack of 200% of normal for the winter season in the mountains around Livingston;
- * Above normal rainfall from late May through mid June; and
- * Unseasonably warm temperatures

In south central Montana, almost all major floods have closely followed heavy rainfall, unseasonably warm temperatures and an above normal snowpack. Due to the abundance of increased flow each spring, there is little foliation in the river (the river bed is scoured out). River flooding can last several days after the rain has stopped due to the run-off from higher elevations. The varied topography of south central Montana can augment heavy rain events from orographic lift.

Snowpack

Snow began to accumulate early at the higher elevations during the 1997 water year. By the end of January 1997, the snow water equivalent for the Upper Yellowstone Basin was 177% of normal and changed very little over the next few months. By May 1, 1997, the snow water equivalent (SWE) in most of Montana's mountains was over 150% of normal (Fig. 1). By June 1, 1997, the SWE for locations immediately surrounding Livingston was between 110% and 130% of normal and at higher elevations the snow water equivalent was over 130% of normal (Fig. 2). During the months of May and June, the recorded SWE, as reported by the National Resources Conservation Service office in Bozeman, Montana for the Upper Yellowstone Basin, fell from 25.6 inches to 15.5 inches in SWE or from 158% of normal to 125% of normal. The snow was beginning to melt at a rapid pace.

The Event

Warmer than normal springtime temperatures invaded southern Montana by mid-May with daytime readings topping out in the 80s. Temperatures at the higher elevations were conducive to snow melt as overnight lows remained above freezing and daytime readings in the 60s. These warmer temperatures in conjunction with the much above normal snowpack brought an early and substantial rise to the rivers across the region. In addition to the above normal temperatures and snowpack, heavy rain events on already saturated snowpack during this period added to the increased water flows (Fig. 3). Figures 3A and 3B show the NWSO Billings HSA River Basins and a close-up of south central Montana River Basins and towns that were affected.

Several cooperative observers reported rainfall amounts ranging from greater than five inches to just under ten inches across southern Montana during the month of June. In most cases, approximately one fourth of the precipitation was received during a 24-hour period. This was the case for Cooke City and Wilsall, Montana, both located within Park County. At Cooke City (elevation of 7460 feet) 1.75 inches was received on the 7th of June, while in Wilsall (elevation of 5835 feet) 1.12 inches fell on the 18th of June. Both stations reported over 5 inches of precipitation for the month of June (Cooke City 5.05 inches and Wilsall 5.70 inches). Figure 4 shows the location of these stations in Park County. In both instances, rain falling on snow events were recorded.

The first of many statements was issued on May 9, 1997 at 4:48 am for rising waters across southern Montana. On May 16 at 12:45 p.m., a Flood Watch was issued for the Yellowstone River near Livingston. The following day, May 17, at 10:06 a.m., the Flood Watch was upgraded to a warning, as the Yellowstone River hovered at 7.5 feet and was expected to rise above the flood stage of 8 feet by the end of the day. This turned out to be premature, as the Yellowstone River at Livingston did not reach flood stage until May 23. The Yellowstone River then fluctuated between a stage of 7 and 8 feet at Livingston through the remainder of May. Then on May 31, the river rose above flood stage and remained above flood stage until June 29. The peak stage of 10.73 feet was reached June 5, a new record stage, exceeding the record stage which had been set one year prior and establishing a 100-year flood event, the second in a two-year period.

Locations downstream and upstream of Livingston also reported flood stages above normal from May 31 through June 29. The Shields River (Fig. 4), which flows into the Yellowstone River downstream of Livingston, reported a peak stage of 6.11 feet on June 12. The flood stage of the Shields River is 5.50 feet. The Boulder River at Big Timber (Fig. 5) which flows into the Yellowstone River downstream of Livingston, reported a peak stage of 7.44 feet on June 1. The Boulder River flood stage at Big Timber is 7.00 feet. Flash flooding on the Boulder River during the month of June also contributed to high flows downstream of Big Timber and affected locations farther downstream on the Yellowstone River. This increased flow was recorded at Billings when the Yellowstone River (Fig. 6) reached a peak stage of 15.00 feet on June 12th. The flood stage in Billings is 13.00 feet.

Conclusion

The USGS reported that the flooding in late May through mid June 1997 was considered a 100-year flood event along the Yellowstone River in Livingston. The Yellowstone River near Livingston reached a record flood stage of 10.73 feet. NWSO Billings issued nearly 150 flood statements, advisories and warnings for this event.

Damage was widespread across the area. Low-land flooding alone from the Shields and Yellowstone Rivers contributed to road repair totaling more than \$294,000. Other damage in and around Livingston to residences, buildings, and facilities totaled close to \$850,000.

For future potential flood events, the 1997 record-setting flood season illustrates the need to be alert during spring to several different parameters. These include the snowpack in the river basins, the antecedent river conditions, unseasonably warm temperatures, and rainfall. All of these parameters were above normal: snowpack, 200% above normal, high flowing rivers due to above normal temperatures in the 80s (during the day) and 60s (during the night), and increased precipitation received, 1/4 of the months total during a 24 hour period, both in the mountains and at the lower elevations.

Throughout the event, constant contact was maintained with county Disaster and Emergency Services officials. This enabled NWSO Billings staff to monitor the situation closely and update statements as needed. Additional monitoring of the event came from extensive use of the Hydromet computer and from local spotters. Shift change briefings and daily map discussions allowed staff members to remain current on the event status. Town meetings early in the spring season informed county residents of the above-normal snowpack and of the potential for serious flooding if various weather scenarios occurred. These meetings helped limit damages incurred and have become a continued practice for NWSO Billings.

MOUNTAIN SNOWWATER EQUIVALENT FOR MONTANA

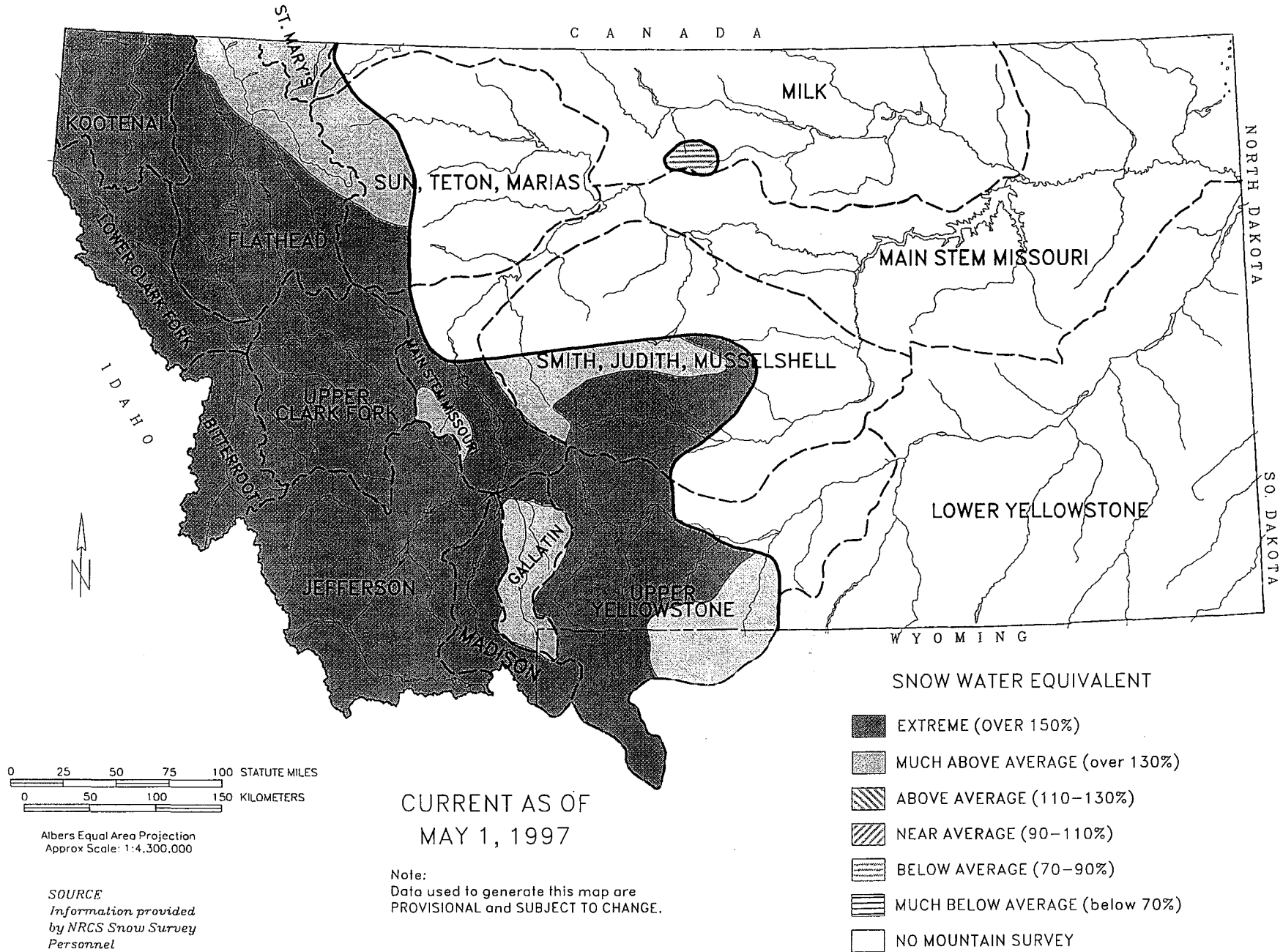


Figure 1. Mountain Snow Water Equivalent for Montana
Source - NRCS, Bozeman, Montana

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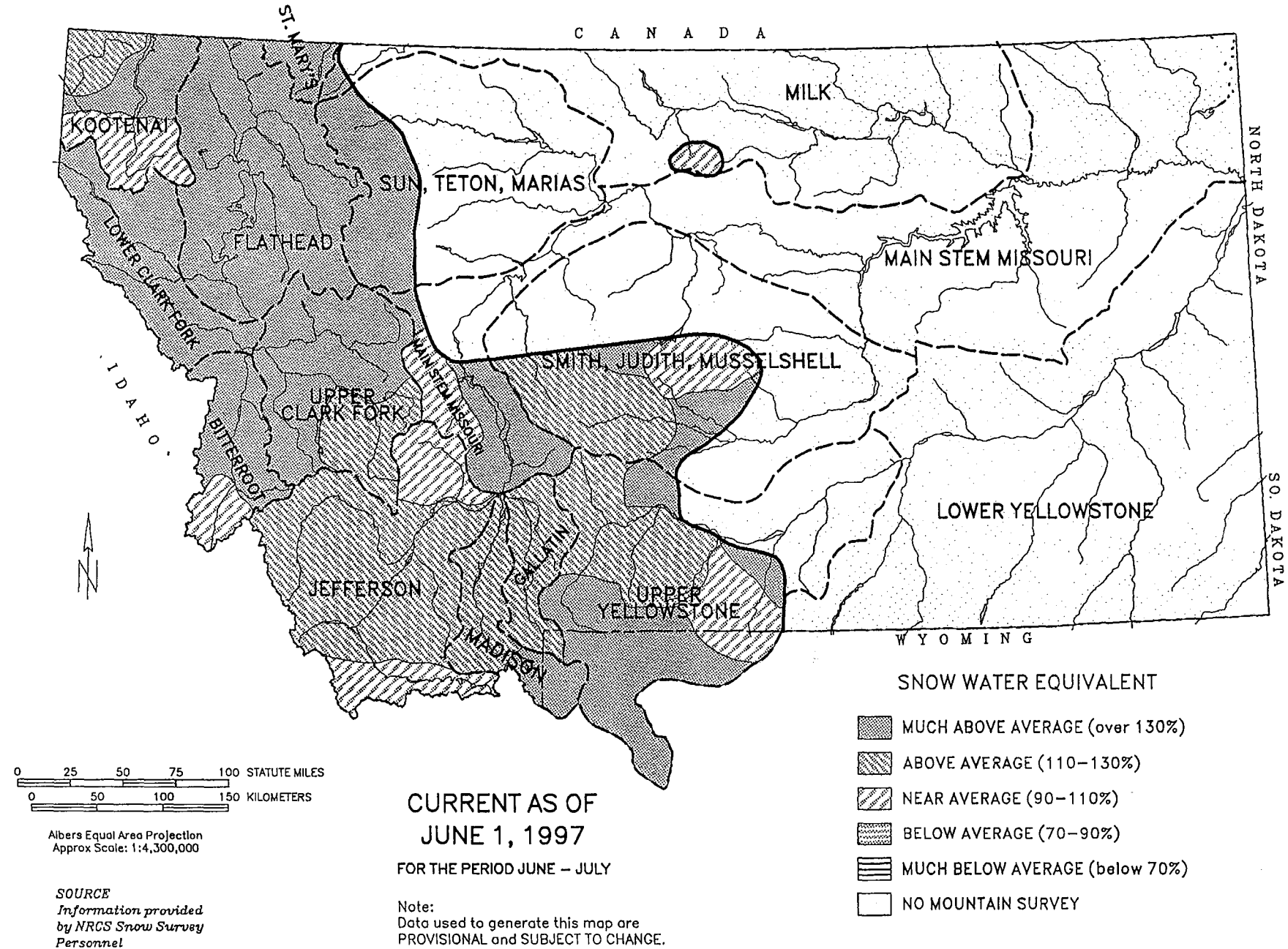


Figure 2. Mountain Snow Water Equivalent for Montana
Source - NRCS, Bozeman, Montana

Figure 3. Close-up of South Central Montana
Counties and Towns affected
WFO Billings CWA

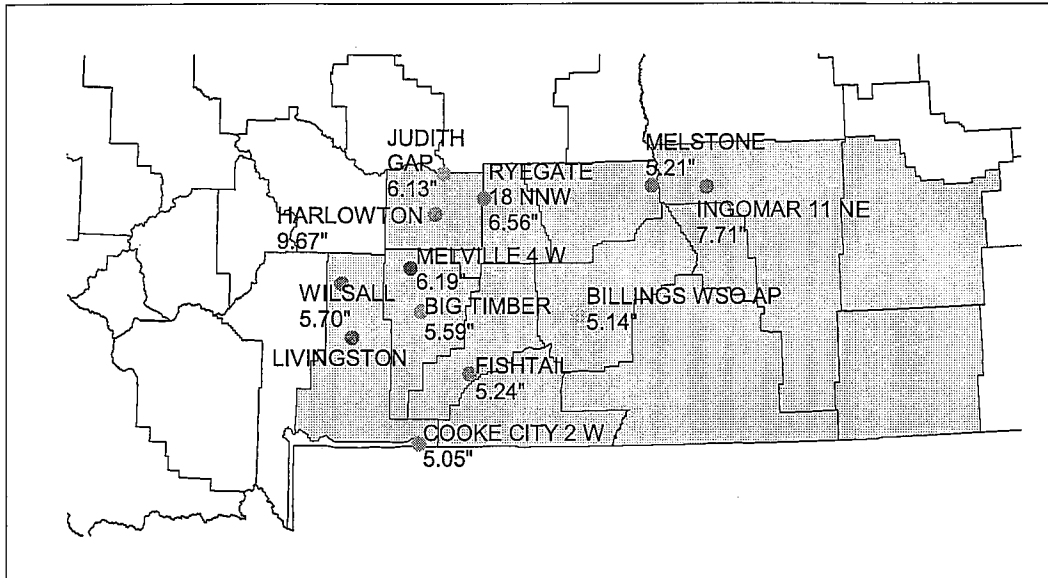


Figure 3A. South Central Montana
 Record Flood of 1997
 WFO Billings HSA River Basins

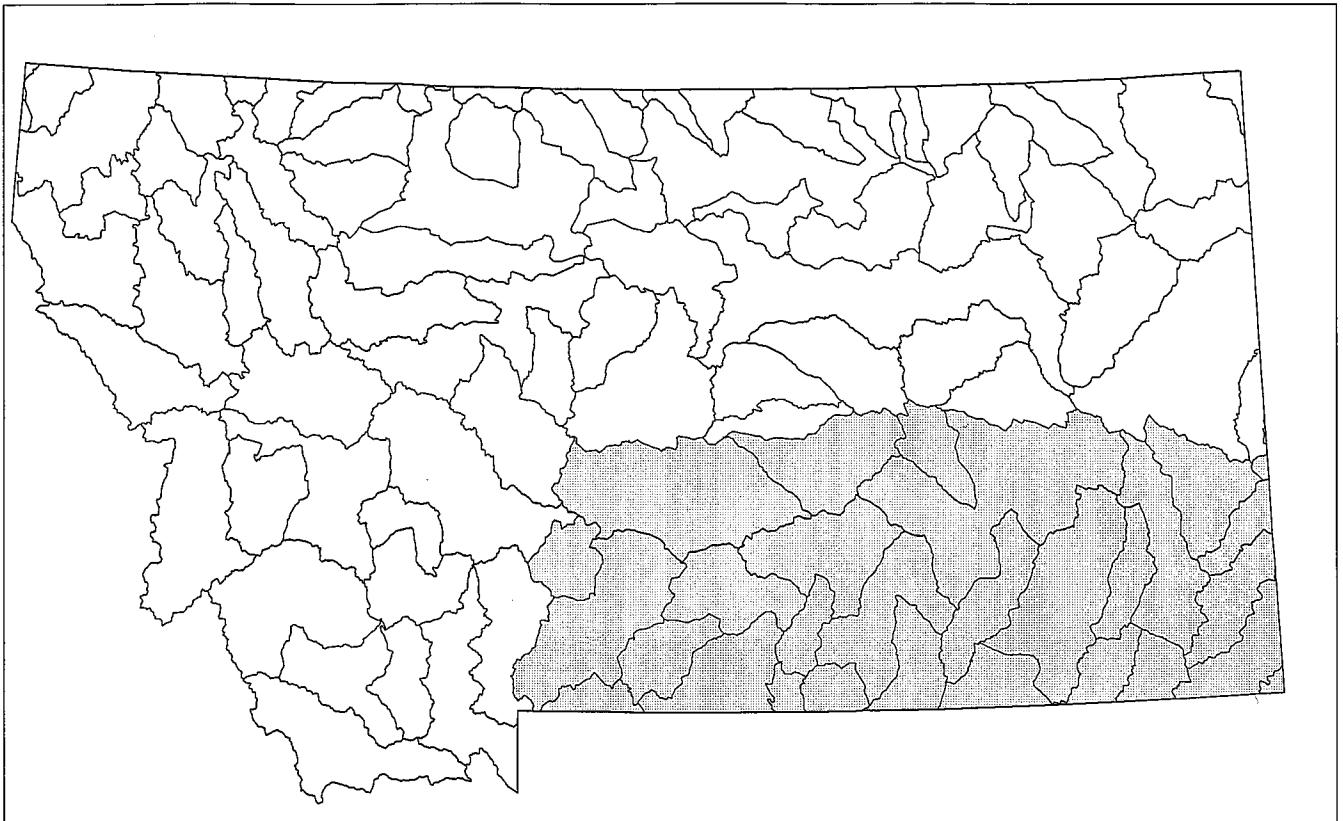
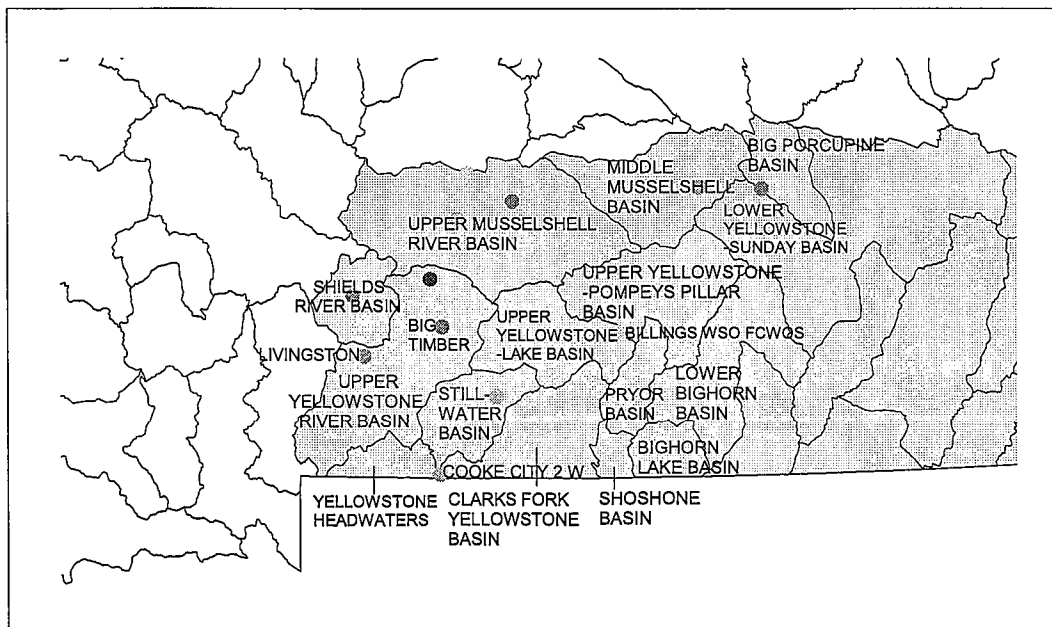


Figure 3B. Close-up of South Central Montana
 River Basins and Towns affected
 WFO Billings HSA



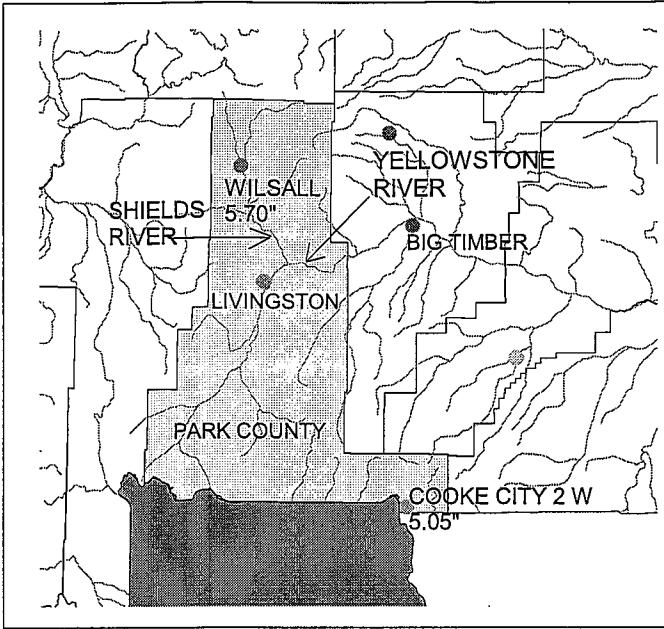


Figure 4. Park County Montana June Precipitation

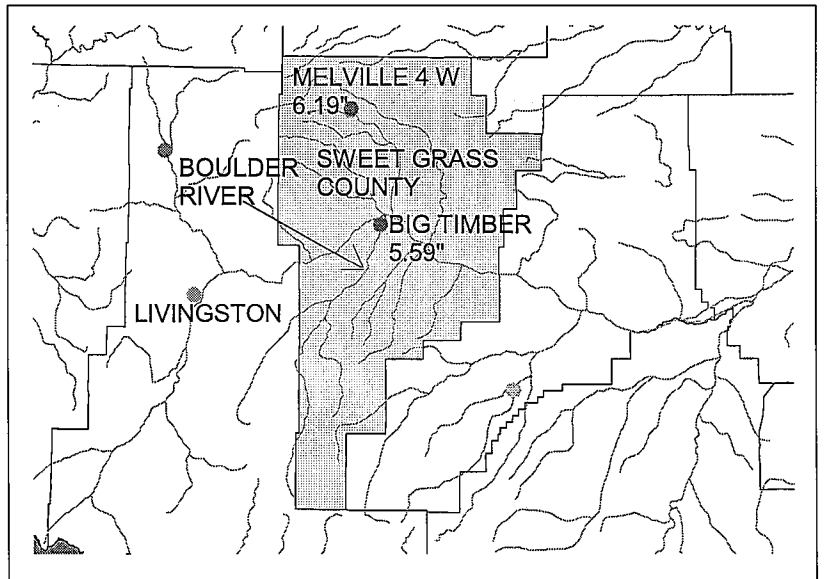


Figure 5. Sweet Grass County Montana June Precipitation

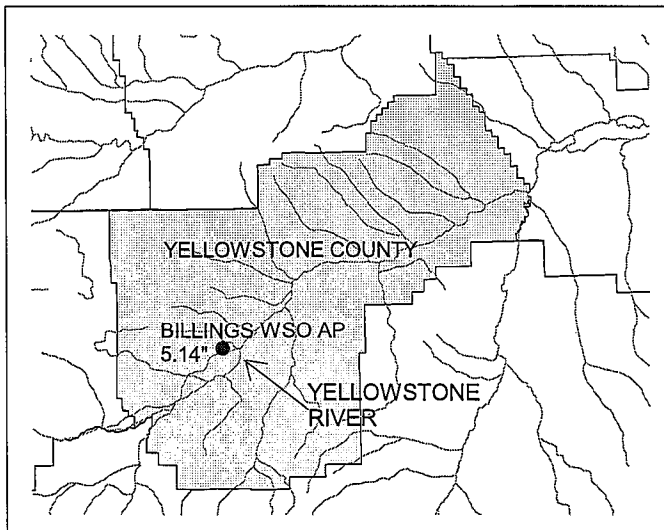


Figure 6. Yellowstone County Montana June Precipitation