July and August are typically the wettest months for large parts of New Mexico because summer monsoon weather patterns bring moist winds up from the Gulf of Mexico and the Gulf of California. This is particularly true in eastern New Mexico. Union County, however, experienced unusually wet and cool weather during the summer months of 2004. From early June to the middle of August nearly 12 inches of rain were reported in some areas of the county (Table 1). The average summer temperature (highs and lows averaged from June through August) was 2.4° below normal, which is fairly significant for the average temperature.

Early in the month of August a succession of four cold fronts moved down from the north, helped along by a high-pressure cell stalled over Alaska. The cold fronts met humid gulf air moving up from the south and east, and every time the two met the unstable humid air was lifted resulting in bands of intense thunderstorms across the eastern plains. On August 11 a particularly strong cold front swept into the eastern high plains, lifting humid air laden with fresh moisture. Showers and many thunderstorms were reported across the state between August 11 and August 14. The most severe storms, including reports of large hail, occurred between the 12th and the 14th (Figs. 1 and 2).

Residents of Clayton and Sedan, the town about 20 mi to the south, and areas in between will long remember the storm that hit around midnight on Friday the 13th and its spectacular aftermath. What the storm lacked in size (estimated at approximately 5 mi²) it more than made up for in intensity. Hail accumulations reaching 12 inches were followed by as much as 5 inches of rain. So much rain fell in such a short period of time that the pea- and marble-sized hail was carried along first as sheetflood and then concentrated in a small drainage tributary to Sand Draw (Fig. 3) estimated to be approximately 15–20 ft deep. Approximately 8 mi south of Clayton just off NM–402 (sec. 10 T24N R35E), the hail began piling up behind a 12–16 ft culvert that was unable to handle the flow. Hail filled the small draw, as rain continued to flow across the fields, through the tons of ice, and onto the highway.

Very early Saturday morning a sleepy Barbara Podzemny got a phone call: “Drive north on NM–402, and bring your camera!” At their place near Sedan, Barbara and her husband Randy got only about an inch of rain during the night, and no hail, yet they drove north toward Clayton and photographed what for all the world

<table>
<thead>
<tr>
<th>Month</th>
<th>Total rainfall (inches)</th>
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<tbody>
<tr>
<td>June</td>
<td>4.89</td>
</tr>
<tr>
<td>July</td>
<td>3.57</td>
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<tr>
<td>August</td>
<td>4.08</td>
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TABLE 1—Rainfall for Clayton, New Mexico, during the summer 2004.
looks like a glacier in Union County. Hail had literally filled the
draw to a height of approximately 15 ft. Saturday morning verti-
cal ice cliffs as wide as 25 ft and 100 yds long framed the torrent of
water flowing through the typically dry draw (See Figs. 4–9).

Late Sunday Louis King with the National Resources Conserva-
tion Service (NRCS) visited the site. A little girl who was happily
excavating the ice with a small pail and shovel uncovered a 1-ft-
long ringneck snake. It was steely gray on its back, and the orange
coloring on its belly wrapped around the back of its head. The tiny
snake was put into a jar where it thawed and was later observed
moving about.

Although hail is commonly formed in thunderstorms, the
dimensions of this accumulation are unique. The ice remained for
nearly a month in spite of long sunny summer days and tempera-
tures into the 80s. In the "precipitating event" 2.28 inches of rain
fell in Clayton on August 13th and 14th. On the 14th of August
alone 1.87 inches of rain was recorded, the greatest 24-hour rain-

FIGURE 3—Map of northeast New Mexico showing location of August 13th hailstorm.

FIGURE 4—Overview looking west at hail accumu-
lation in a tributary to Sand Draw approxi-
mately 8 mi south of Clayton. The hail was con-
centrated into an ice sheet estimated to be 100
yds long, 25 ft wide on either side of the chan-
nel, and 15 ft thick.

FIGURE 5—Water from the previous night’s deluge and melting ice flows
between ice cliffs as high as 15 ft. Randy Podzemny, who is 6 ft 5 inches
tall, stands near the bottom of the draw. Note the bedding patterns in the
ice from varying amounts of debris and soil deposited with the hail.

FIGURE 6—Looking west upstream from Figure 5.

FIGURE 7—View of an ice cave formed as water drains into the draw from
fields to the south. Windmill just beyond hail accumulation is barely visi-
ble at the top of the photo.
Hail strikes Socorro

October 5th is well past the end of summer and presumably the end of summer storms, but this continues to be the year of unusual weather. On October 4th and 5th several severe storms containing large hail moved through the Albuquerque area, and on the 5th were reported in Belen and Socorro; near Encino, Picacho, Vaughn, and Lovington; and between Dexter and Hagerman. At New Mexico Institute of Mining and Technology in Socorro, hail between 2 and 3 inches in diameter bombarded buildings and vehicles causing more than $10 million in damage on the campus.

Estimates of storm damage city wide were at least $10 million as well. I calculated that the terminal velocity achieved by a 2-inch-diameter spherical hailstone would be 78 mph, whereas a 3-inch-diameter hailstone would hit the ground at more than 95 mph. The more typical pea-sized hail, if it were assumed to be one-fifth inch in diameter, would reach a terminal velocity of slightly over 25 mph. A comparison of momentum transferred on impact shows that the 3-inch hail packed more than 3,500 times the momentum of one-fifth-inch hail. These fierce terminal velocities of 80–95 mph are identical to the updraft velocities necessary to create 2–3-inch-diameter hail. In fact updraft velocities actually exceed 95 mph because air density is lower at the elevation where hail is created. [I made these calculations using a simple newtonian drag model, in which drag force is proportional to velocity cubed and the cross sectional area of the falling object. Hail density was taken to be 920 kg/m³, and air density at Socorro’s elevation was taken to be 1.00 kg/m³.]

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Acknowledgments

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—Jane C. Love
New Mexico Bureau of Geology
and Mineral Resources