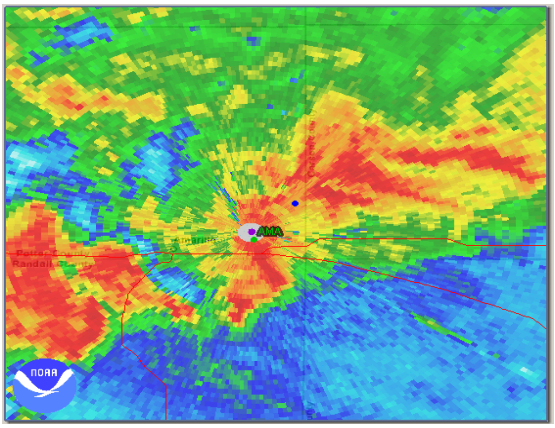
Post-Analysis of the Potter/Randall Flash Flood Event: July 7-8, 2010



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Introduction

On July 7-8, 2010, rain showers produced flash flooding across Potter and Randall counties in the Texas Panhandle. Over a three hour period, heavy intense rainfall caused many of the streets to become impassable, stalling numerous vehicles caught in rapid rising waters, and required emergency personnel to respond to over 30 swift water rescues throughout the city. Additionally, many businesses and homes in east and southwest Amarillo sustained minor flooding. Among the most costly damage occurred to three facilities located east of Amarillo - the Highland Park Elementary School, Pantex, and the Rick Husband Amarillo International Airport. Highland Park School observed the highest storm total of 11.04 inches of rainfall and experienced two to four feet of water in parts of the school. Significant flooding along Highway 60 and flooded roadways leading to the Pantex facility forced the plant to close on Thursday, July 8. Meanwhile, Rick Husband Amarillo International Airport saw a storm total of 7.33 inches of rainfall which flooded the entire basement, crippling essential equipment and requiring personnel to revert to alternative measures to ensure continuation of airport operations.

Flash flooding events are common to the Texas Panhandle region, especially during the spring and summer months. Record rainfall over a short period of time can quickly overwhelm storm water systems and result in flooding in excess of any previous occurrence. But how unique was this particular storm system? Were there other contributing factors that caused such extensive flooding to the airport facility? This report aims to document the July 7-8, 2010 flash flooding event meteorologically through analysis of weather data and flood reports, climatologically through comparison to prior significant flash flooding events, and includes a site-specific assessment of the Rick Husband Amarillo International Airport for the evolution of events leading to the extensive flooding.

Storm Synopsis

A very moist, tropical environment was characterized over the Texas Panhandle on July 7 (Figure 1 and Figure 2). Surface observations at 12Z (7 AM CDT) show the moisture plume of rich 60+ dewpoints (numbers in green) extending into the Texas Panhandle with a cold front exiting SE Colorado. Data from the Rick Husband Amarillo International Airport weather station (Figure 1) shows the cold front passed through Amarillo at about 1 PM on July 7. Aloft, a weak steering flow was present with only 5-10 knots suggesting any storm development that was forecasted to occur would be slow moving. By 00Z (7 PM CDT) the cold front had stalled over the central Texas Panhandle. It was the combination of the weak low level flow, a moist and unstable environment, and a stalled cold front that would play contributing factors in convection behavior later that evening. Additionally numerous outflow boundaries served as initiation points for development and continued re-development.

Timeline and Observations

The Amarillo Weather Forecasting Office issued a total of five watch and warning products during the event (Table 1) . An initial Flash Flood Watch was issued at 3:21 PM CDT for the entire Texas and Oklahoma Panhandle that included Potter and Randall Counties until July 8, 2010. As the evening progressed and storms developed along a stalled cold front, KVII SchoolNet data of rapid rainfall rates at 9:00 PM, accompanied by reports of flooded roadways, urged forecasters to issue an Urban and Small

Stream Flood Advisory at 9:06 PM. The KVII SchoolNet site was reporting near 4 inches of rain in slightly over an hour and flooding was becoming an issue along Highway 60 and for Highland Park School itself. With continued storm development and little to no cell movement, a Significant Weather Advisory was issued at 10:33 PM for Potter and Randall Counties. Continued rainfall and increased reports of flash flooding throughout the city prompted a Flash Flood Warning at 10:53 PM. As waters drained and receded but with light showers still in the area, a Flood Warning was issued at 4:49 AM.

Storm evolution depicted by KAMA NEXRAD Radar Imagery is shown in Figure 3 and Figure 4 from 7 PM CDT July 7, 2010 to 12:20 AM CDT July 8, 2010. Rapid initiation occurred at approximately 7:07 PM as a cell developed along a boundary east of Amarillo (Figure 3 a). The storm continued to develop, moving northwestward with additional development extending to the southwest. Additional cells emerged along another boundary to the north of the city. Showers continued to develop and fill along and west of the city with the most intense showers over the area ending after midnight.

Total official rainfall reports received for the event are shown in Figure 5. Station locations are depicted by the blue squares. Data was acquired from the NWS KAMA ASOS station located at the airport, NWS Co-op Observers, NWS Supplementary reports, KVII SchoolNet sites (Highland Park School, The Colonies, and Sleepy Hollow), and the Pantex Weather Network (8 stations). KVII SchoolNet sites and Pantex sites are totals for July 7-8 (12 AM – 12 AM). NWS KAMA site is recorded around 12 AM CST so the data range is from 1 AM – 1 AM). Co-op observations and supplementary reports are reported from 8 AM – 8 AM.

The higher rain totals were seen NE of Amarillo along Highway 60 and north of I40, extending from the airport and northward to Highland Park Elementary School and Pantex. These totals ranged from 6.38 to 11.04 inches. Areas in SW Amarillo also saw significant rainfall totaling 4-5 inches along Coulter and Soncy. Radar estimated 24-hour precipitation with recorded observations (Figure 6) shows the swath of higher accumulations in SW Amarillo and the areas NE of the city. Communication with NWS forecasters on duty the night of the event confirm that radar estimations were fairly accurate throughout the night.

Hourly observed observations from selected locations across Amarillo time history and accumulation totals are given in Figure 7 and Figure 8. These include the KAMA site (located at the airport) and the SchoolNet sites at Sleepy Hollow and The Colonies. Due to power failures, the Highland Park School hourly data was incomplete but once it came back up and continued logging, total rainfall accumulations were accounted for.

Communication with KVII SchoolNet administrator Steve Kersh and records in Pidgin indicate that during 9-10 PM the maximum rainfall rate was 8.76 inches per hour at the Highland Park School. Highland Park showed a total of 7.16 inches once it came back online at midnight. We do know that water was entering the school around 10 PM. Radar imagery and the Highland Park School location Figure 10 show a nearly stationary cell over the school that was the root of intense rainfall over the site.

Within a 3-hour window (from 9 PM – 12 AM), the airport weather site saw 4.78 inches of rainfall. Table 2 shows the breakdown by hour. 1.99 inches fell between 10-11 PM with an additional 2.51 inches between 11 PM – 12 AM. Areas in SW Amarillo saw the greatest accumulation (2.47 and 2.83 inches)

between 11 PM and 12 PM. Figure 11 shows the reporting weather stations at a time of heavy rainfall near the airport and Pantex facility at 10:57 PM.

Flash flood reports received by the NWS and Amarillo Emergency Communications Center dispatch data for the evening depict areas within the city and county where flooding overwhelmed roadways, resulting in emergency crews having to respond to stalled vehicles caught in rushing water. A total of 32 swift water rescues took place. In Figure 9, red dots indicate intersections water rescues crews were dispatched to and yellow triangles indicate other reports received. Table 3 lists times and descriptions of the official NWS flash flood reports. Breaking the rescues over hourly and plotting them in conjunction with radar data midpoint timeframe, the roadways with the greatest flooding problems are revealed. Between 11 PM – 12 AM CDT which coincided with the greatest accumulation of rainfall in SW Amarillo, the majority of water rescues (white squares) were in the western portions of the city (Figure 12). As the storm progress westward, flooded roadways extended towards the downtown area and I27 corridor (Figure 13 and Figure 14).

Record Events

The amount of rain that fell during this event broke five different records (Table 4). The Rick Husband Amarillo International Airport ASOS site is located in the northeastern part of airport property and has been in service since April of 1932. Appendix 1 lists the history of the location and upgrades to this particular weather station. Daily observations recorded at the site are recorded and considered official record and used for normal, mean, and extreme climatologically analysis. It should be noted that heavy rainfall may fall in parts of the city with little to no rainfall at the site itself or vice versa. Rainfall frequency statistics are generated based on data collected from these official sites.

A daily record rainfall of 5.74 inches was observed on July 7, 2010, breaking the previous record of 1.78 inches back on July 7, 1960. Additionally and perhaps of more significance was the record of the all time daily maximum rainfall record. This day saw more rain between 1 AM to 1 AM CDT (or 12 AM to 12 AM CST) than any other day of the year since records were kept. This total was 0.82 inches more than the previous record of 4.92 inches on June 10, 1984 and remains the only record greater than 5 inches over a day. This is illustrated in Table 5 where the highest daily precipitation record for each day of the year are depicted by varying color: grey (0 to 1 inch), purple (1 to 2 inches), blue (2 to 3 inches), yellow (4 to 5 inches), and red (>5 inches). High record rainfall events are not necessarily flash flood events. By definition flash flooding is an intense amount of rainfall over a short period of time. Some of the record breaking events could be large snowfall events, heavy rainfall spread throughout the 24 hour day causing little to no flooding, or accumulating daily total of separate morning and afternoon thunderstorms. For the July 7th event, such an intense amount of rainfall generally over a 3 hour period and being the highest amount ever recorded is of quite significance. Dates were obtained for the top ten extreme daily precipitation events. They are as follows below. Flash flooding documentation and reports are often difficult to obtain but an initial investigation into the NCDC Storm Reports through thunderstorm reports archived suggest that the majority of these events were associated with thunderstorm activity. Precipitation duration/intensity analysis was not performed due to time constraints but would further enhance investigation to the uniqueness of the July 7-8 flash flood event.

AMARILLO INTL AP (410211) Extremes - Highest Daily Precipitation (inches)
Days: 1/1 - 12/31 Length of period: 1 day
Years: 1941-2010

Rank Value Ending Date

- 5.74 7/7/2010
- 4.92 6/10/1984
- 4.08 7/8/1943
- 4.06 6/9/1960
- 3.95 5/15/1951
- 3.70 5/16/1951
- 3.69 6/20/1958
- 3.58 8/26/1979
- 3.47 7/29/1997
- 3.46 6/24/1948

Other records broken include the record daily rainfall for July (previous record July 8, 1943) and a record monthly rainfall (July 1-9) of 7.93 inches. The previous record was July 1960 with 7.59 inches. The record 24-hour rainfall was 7.25 inches, 0.5 inches greater than the previous record in May 15-16, 1951 (6.75 inches).

Collaboration with local NWS forecasters aimed to see how the July 7-8 event compared to other regional flash flood events. Investigation into local E-5 reports (monthly reports of hydrologic conditions) by the Amarillo NWS Hydrologist found that just about every summer since 1996 the Amarillo forecasting area has had some location report 8-10 inches of total rain for at least one month during the summer. Rainfall observations included in these reports come from not only the ASOS stations, but co-op and supplemental observations as well.

The most significant major floods from 1996 to present day are as follows below. The greatest rainfall producer was the April 1997 Clarendon flash flood which saw over 11 inches over a short period of time. This event is comparable to the recorded 11.04 inches seen at Highland Park School for the July 7-8, 2010 case. The observed 7.33 inches at the airport itself would make the 2010 flash flood event one of the top four highest rainfall flash flooding events in the Texas Panhandle region.

- **April 1997 Clarendon Flash Flood**: 11 inches of rain over a short period (record flood)
- **July 1999 Amarillo and Palo Duro Flash Flood:** 3-4 inches of rain within two hours in SW Amarillo
- **May 2001 Clarendon Flash Flood**: over 9 inches of rainfall
- **July 2002 Amarillo Downtown Flash Flood**: damage to some buildings downtown, numerous cars stalled under underpasses, 1 fatality
- **June 2004 Stinnett Flash Flood**: radar estimated 6-7 inches in a couple of hours
- **September 2004 Borger Flash Flood:** 4-6 inches over a short period of time
- **August 2006 West Amarillo Flash Flood :** >4 inches, 1 fatality
- **June 2010 Spearman/Hansford County**: >10 inches of rain, $1.4 million in damage to county roads and bridges, 44 homes damaged

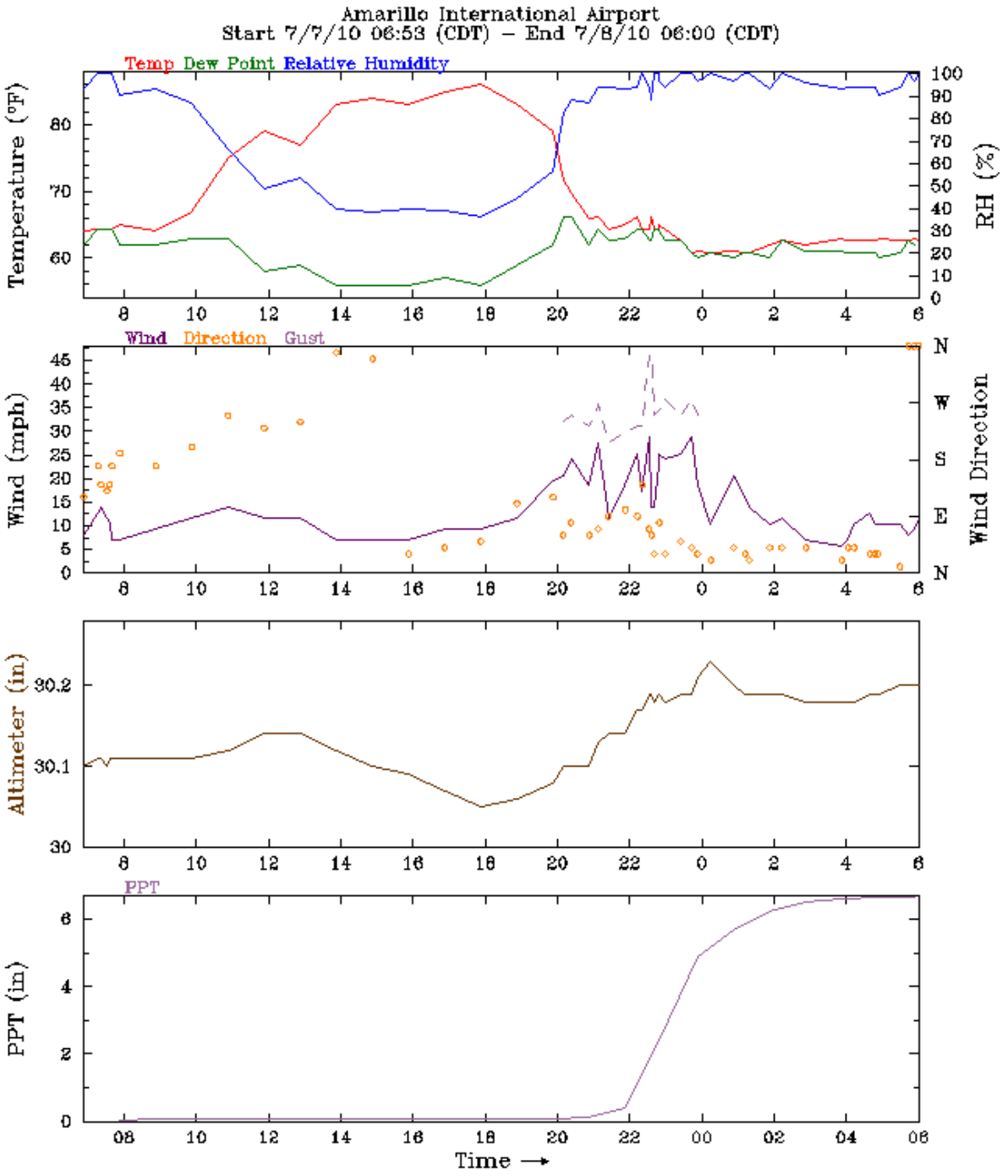
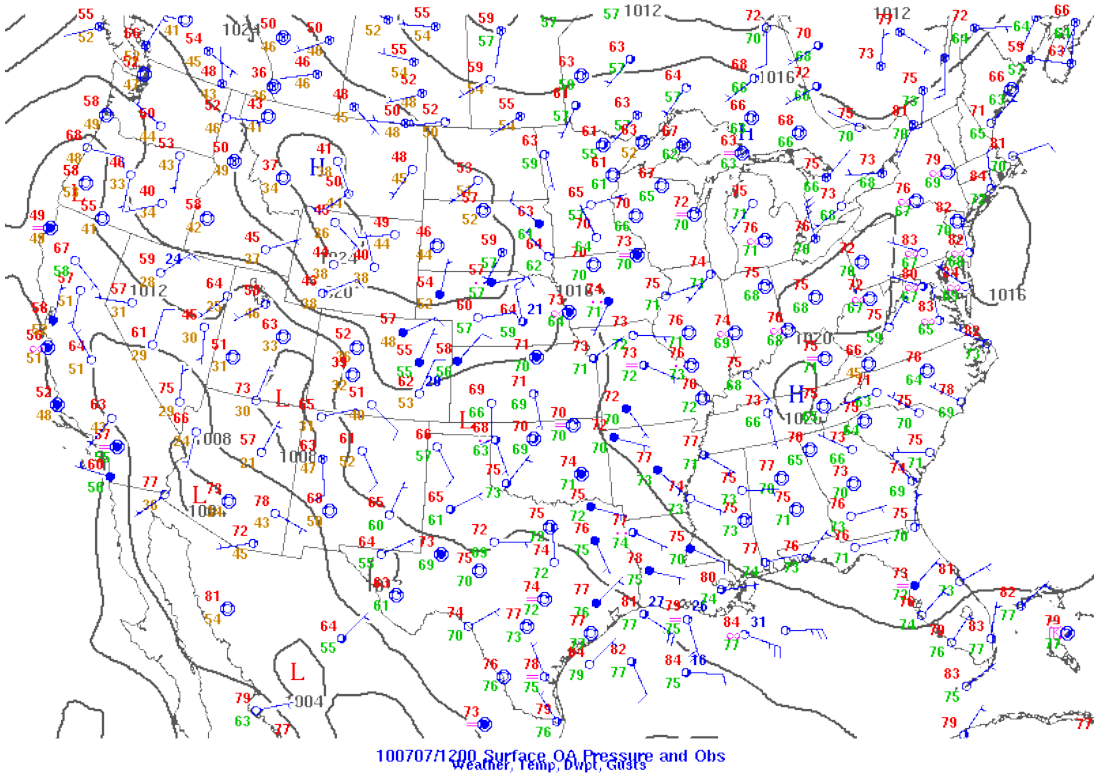
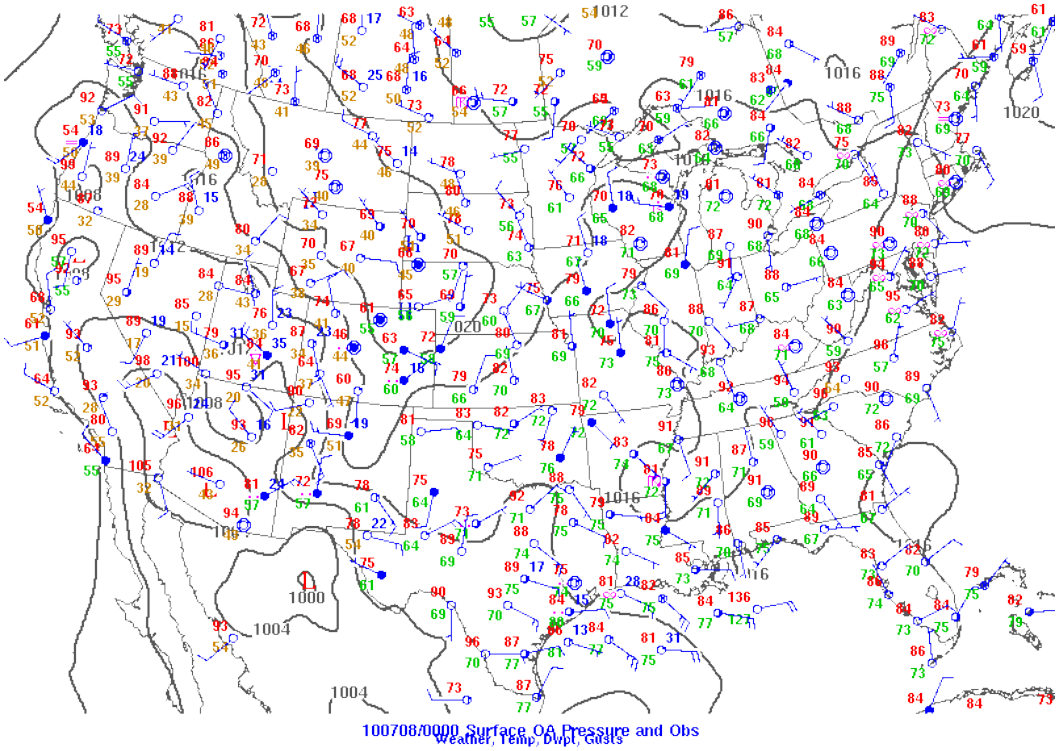


Figure 1: Surface Observations for Rick Husband Amarillo International Airport (NWS, 2010).



a)



b)

Figure 2: Surface Observations for a) July 7 12Z (7AM) and b) July 8 00Z (7PM).

Time	Description
321 PM JULY 7	**FLASH FLOOD WATCH** issued for the entire Texas and Oklahoma Panhandles including Potter/Randall Counties through Thursday evening (July 8)
906 PM JULY 7	**URBAN AND SMALL STREAM FLOOD ADVISORY** issued for Eastern Potter County until 12:00 AM CDT. At 9:00 PM reports of water out of the ditches along Hwy 60 near Highland Park Elementary School. The Schoolnet sight at Highland Park Elementary School has received near 4 inches of rain in slightly over an hour. The storm is spreading toward the City of Amarillo.
1033 PM JULY 7	**SIGNIFICANT WEATHER ADVISORY** issued until 11:15 PM for Randall and Potter Counties. At 10:30 PM NWS detected a strong thunderstorm over Amarillo. This thunderstorm is nearly stationary.
1053 PM JULY 7	**FLASH FLOOD WARNING** issued for Potter and Randall County until 4:45 AM.
449 AM JULY 8	**FLOOD WARNING** issued for Potter and Randall County.
311 PM JULY 8	**FLASH FLOOD WATCH** canceled.

Table 1: Amarillo NWS Watch and Warning Products for July 7-8, 2010 (NWS, 2010).

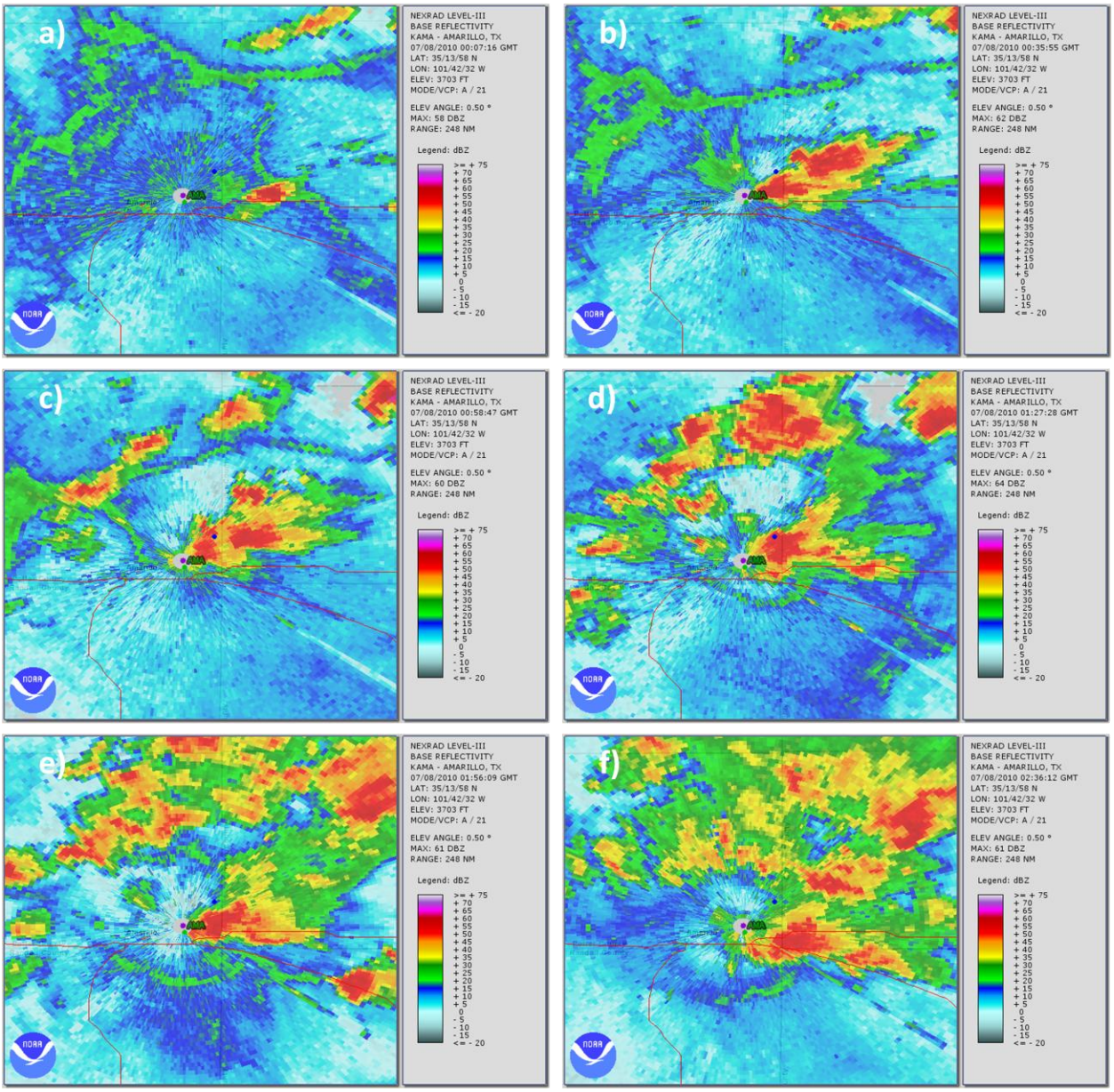


Figure 3: KAMA Base Reflectivity a) 0007Z (707 PM), b) 0035Z (735 PM), c) 0058 Z (758 PM), d) 0127Z (827 PM), e) 0156 (856 PM), f) 0236Z (936 PM).

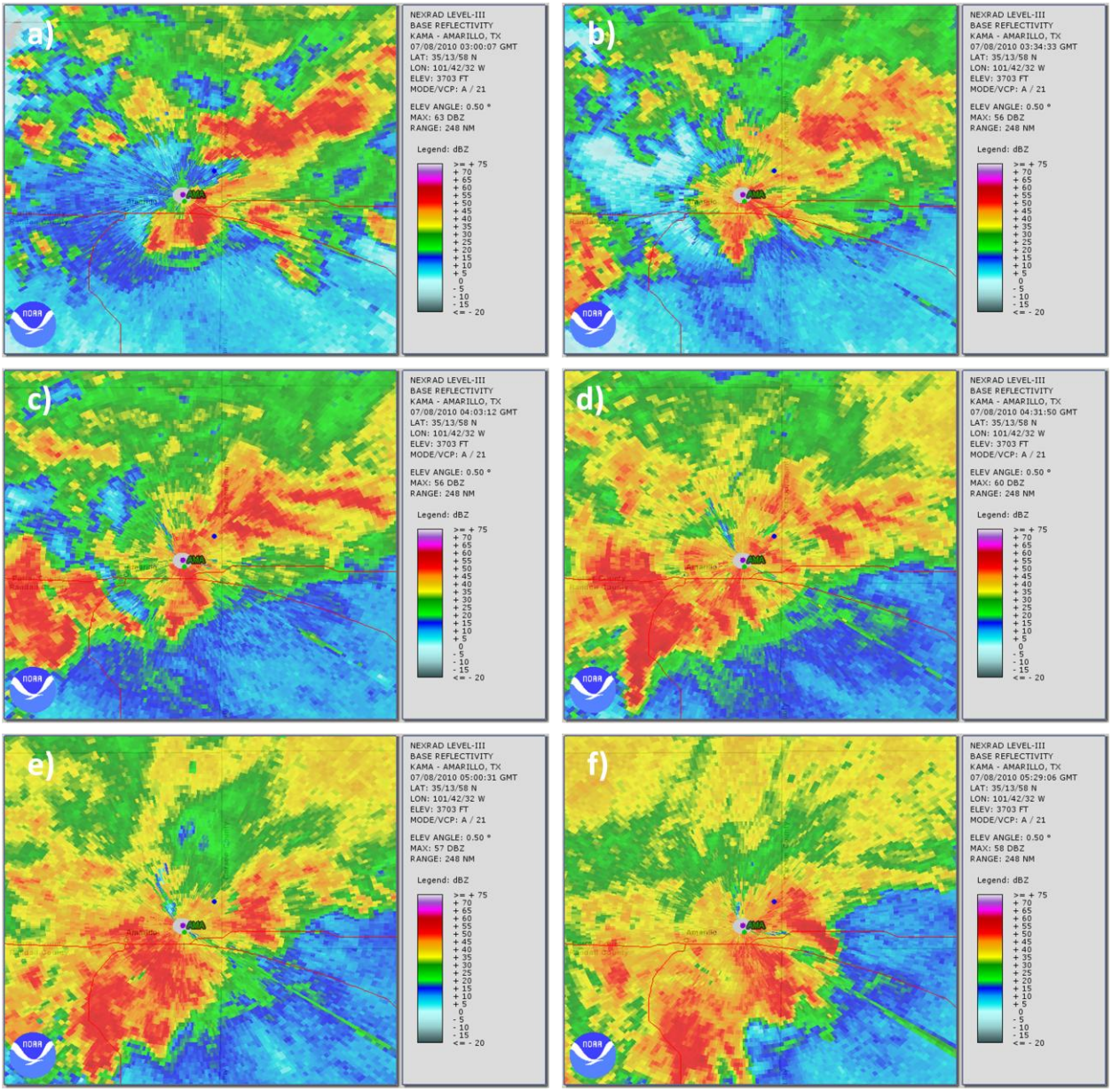


Figure 4: KAMA Base Reflectivity a) 0300Z (10 PM), b) 0334Z (1034 PM), c) 0403Z (1103 PM), d) 0431Z (1131 PM), e) 0500 (12 AM), f) 0529Z (1229 AM).

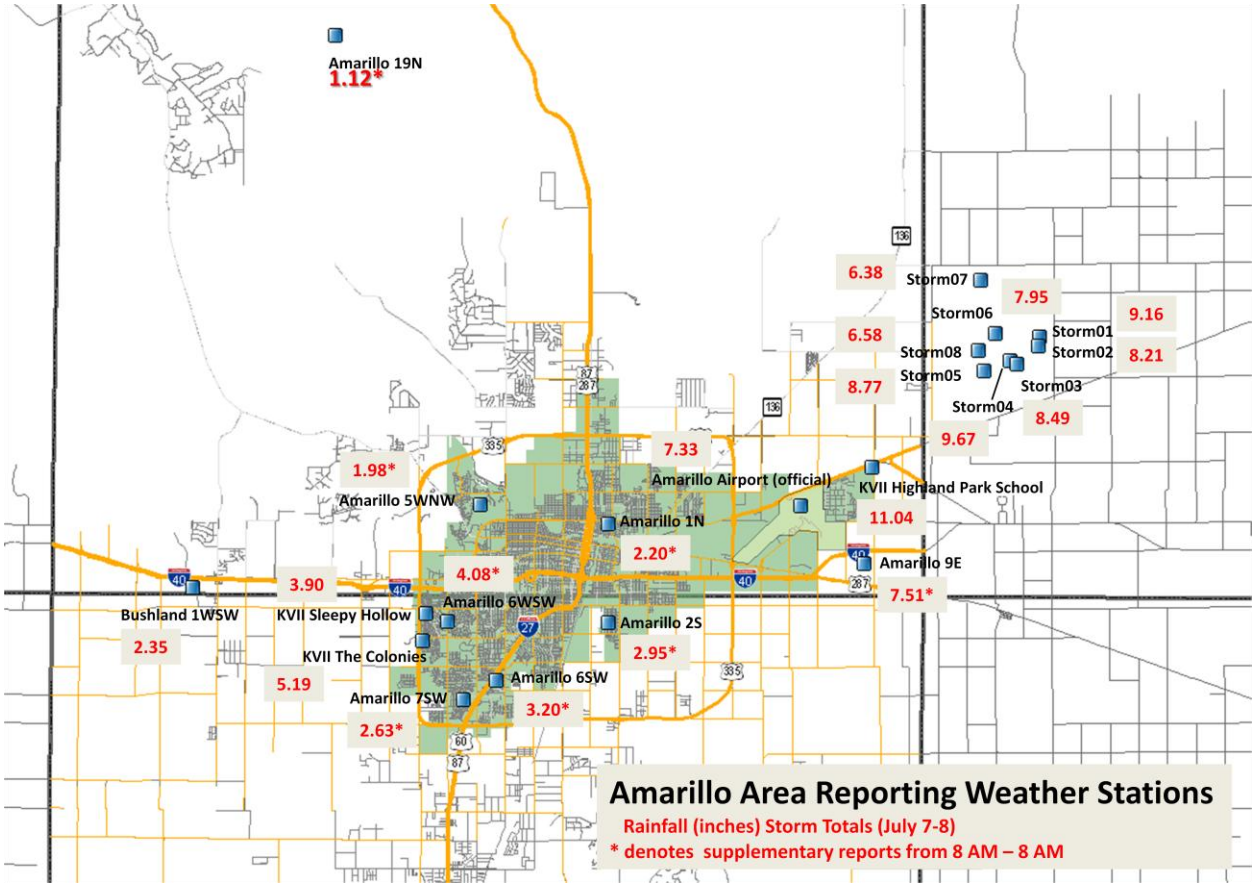


Figure 5: Total storm reported rainfall (inches).

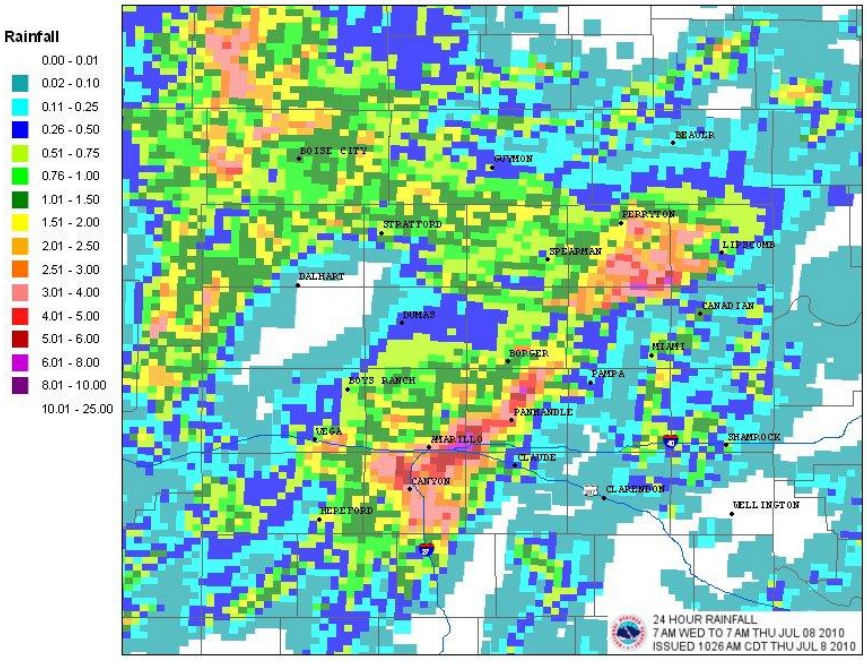


Figure 6: 24-hour precipitation through 7 AM July 8 (NWS, 2010).

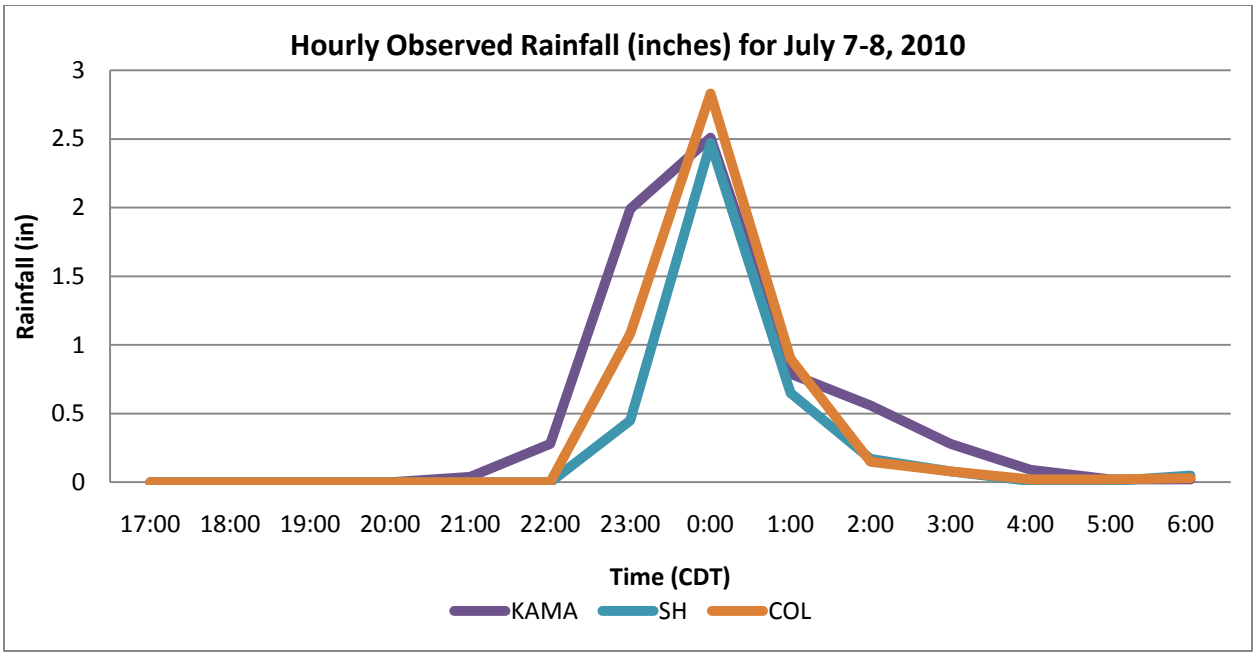


Figure 7: Hourly observed rainfall (inches) for July 7-8, 2010.

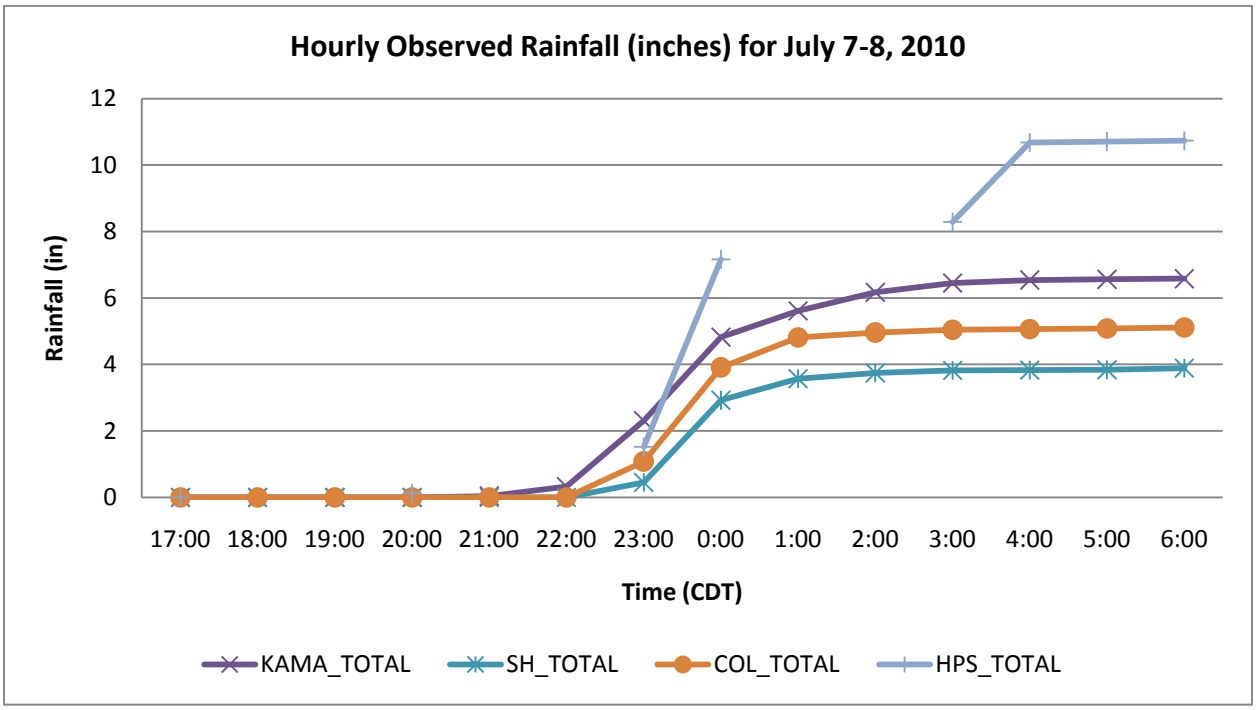


Figure 8: Accumulating running total precipitation for July 7-8, 2010.

DATE	TIME	KAMA	KAMA_TOTAL	HPS	HPS_TOTAL	SH	SH_TOTAL	COL	COL_TOTAL
7/7/2010	17:00	0	0	0	**0**	0	0	0	0
7/7/2010	18:00	0	**0**	--		0	**0**	0	**0**
7/7/2010	19:00	0.00	**0**	--		0	**0**	0	**0**
7/7/2010	20:00	0.00	**0**	--	**0.12**	0	**0**	0	**0**
7/7/2010	21:00	0.04	**0.04**	--		0	**0**	0	**0**
7/7/2010	22:00	0.28	**0.32**	--		0	**0**	0	**0**
7/7/2010	23:00	1.99	**2.31**	--	**1.52**	0.45	**0.45**	1.08	**1.08**
7/8/2010	0:00	2.51	**4.82**	1.13	**7.16**	2.47	**2.92**	2.83	**3.91**
7/8/2010	1:00	0.79	**5.61**	--		0.65	**3.57**	0.9	**4.81**
7/8/2010	2:00	0.56	**6.17**	--		0.17	**3.74**	0.15	**4.96**
7/8/2010	3:00	0.28	**6.45**	--	**8.29**	0.08	**3.82**	0.08	**5.04**
7/8/2010	4:00	0.09	**6.54**	0.03	**10.68**	0.01	**3.83**	0.02	**5.06**
7/8/2010	5:00	0.02	**6.56**	0.02	**10.71**	0.01	**3.84**	0.02	**5.08**
7/8/2010	6:00	0.02	**6.58**	0	**10.73**	0.05	**3.89**	0.03	**5.11**

Table 2: Observed hourly rainfall amounts (inches).

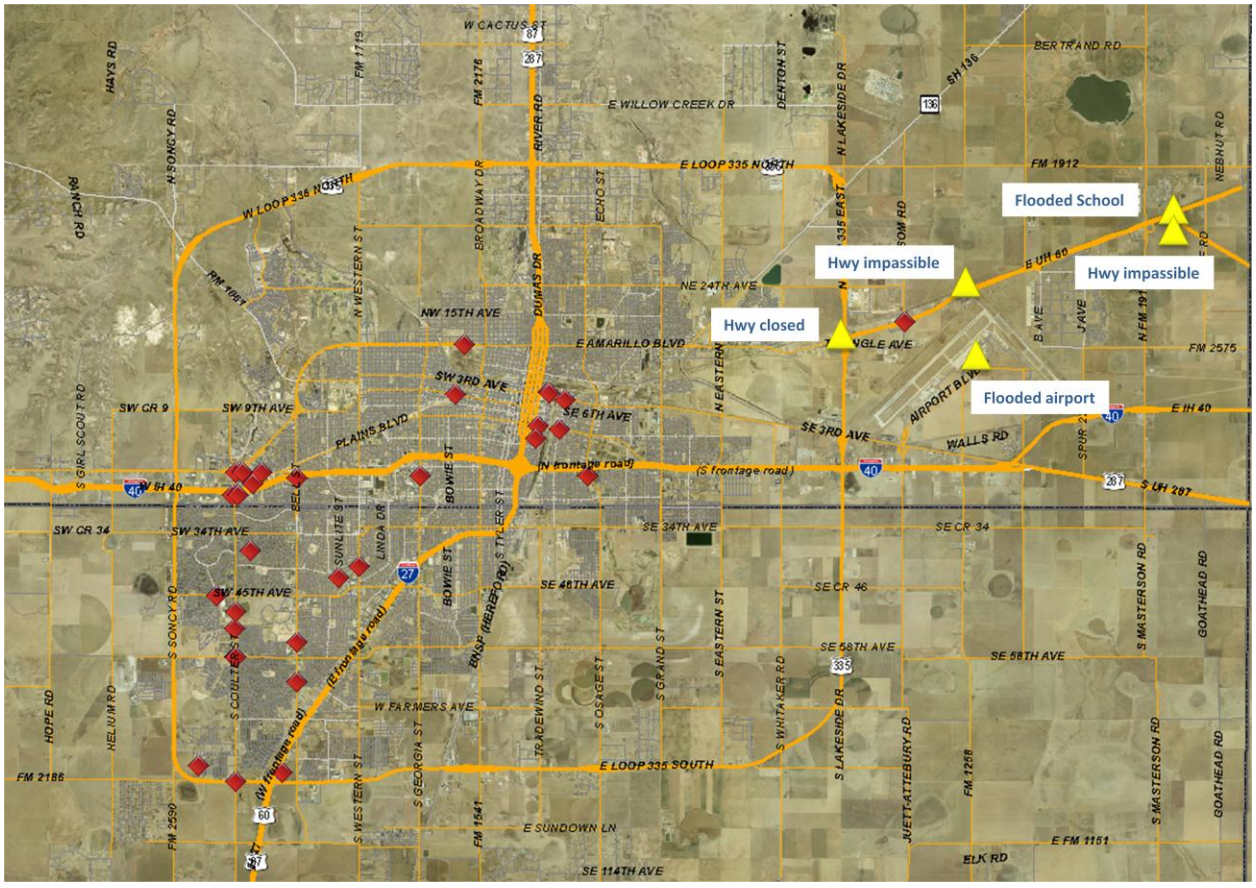


Figure 9: Water rescues and flash flood reports for July 7-8, 2010.

Time	Location	Reported By	Description
1004 PM JULY 7	9 E AMARILLO	SCHOOL OFFICIAL	WATER REPORTED INSIDE THE HIGHLAND PARK SCHOOL CAFETERIA DUE TO HEAVY RAINS OF 5.73 INCHES
1047 PM JULY 7	9 E AMARILLO	SCHOOL OFFICIAL	ANKLE TO KNEE DEEP WATER IN THE ELEMENTARY WING OF THE HIGHLAND PARK SCHOOL DUE TO 6.53 INCHES OF RAIN
1049 PM JULY 7	9 ENE AMARILLO	NWS EMPLOYEE	RAEF ROAD SOUTH OF HIGHWAY 60 IMPASSABLE DUE TO FLASH FLOODING
1122 PM JULY 7	3 W AMARILLO	LAW ENFORCEMENT	NUMEROUS CARS STALLED IN HIGH WATER ON I-40 AND COULTER ACCESS ROAD
1130 PM JULY 7	4 W AMARILLO	LAW ENFORCEMENT	I-40 AND BELL STALLED CARS DUE TO HIGH WATER
1132 PM JULY 7	7 E AMARILLO	LAW ENFORCEMENT	HIGHWAY 60 2 MILES EAST OF LOOP 335 WATER COVERING 3 CARS IN DITCH
1135 PM JULY 7	9 SW AMARILLO	LAW ENFORCEMENT	HOLLYWOOD AND COULTER HIGH WATER RESCUE
1136 PM JULY 7	7 E AMARILLO	LAW ENFORCEMENT	HYWY 60 CLOSED AT LOOP 335 DUE TO HIGH WATER
1137 PM JULY 7	3 W AMARILLO	LAW ENFORCEMENT	I-40 AND COULTER HIGH WATER RESCUE
1152 PM JULY 7	7 E AMARILLO	LAW ENFORCEMENT	HIGH WATER RESCUES WITH WATER UP TO THE ROOF TOPS 2 MILES EAST OF LOOP 335 AND HYWY 60
1200 AM JULY 8	PANHANDLE	LAW ENFORCEMENT	293 WEST BETWEEN 1342 AND 2373 CLOSED DUE TO HIGH WATER
1213 AM JULY 8	AMARILLO	LAW ENFORCEMENT	HIGH WATER RESCUE AT LA FIESTA RESTAURANT ON ROSS STREET
1238 AM JULY 8	2 NW CANYON	NWS EMPLOYEE	COUNTRY CLUB ROAD IN HUNSLEY HILLS IS COVERED BY BETWEEN 2 AND 3 FEET OF WATER
1248 AM JULY 8	8 E AMARILLO	CITY OFFICIAL	AMARILLO AIRPORT REPORTING WATER COMING IN AT THE TERMINAL ENTRANCE WITH 5-6 INCHES OF WATER IN THE BAGGAGE AREA. COMPUTER SYSTEMS ARE DOWN DUE TO THE WATER.
0104 AM JULY 8	9 E AMARILLO	BROADCAST MEDIA	HIGHLAND PARK SCHOOL SUPERINTENDENT REPORTS 2 TO 4 FEET OF WATER IN THE SCHOOL
0132 AM JULY 8	4 SW AMARILLO	LAW ENFORCEMENT	HIGH WATER RESCUE AT RIDGECREST AND TECKLA
0219 AM JULY 8	4 SE PANTEX	TXDOT	HIGHWAY 60 NEAR PANTEX IS CLOSED
0435 AM JULY 8	10 E AMARILLO	EMERGENCY MNGR	AT RICK HUSBAND AMARILLO INTERNATIONAL AIRPORT…BASEMENT FLOODED TO THE TOP. 12 INCHES OF WATER ON FIRST FLOOR

Table 3: Flash Flood Reports received by the Amarillo NWS.

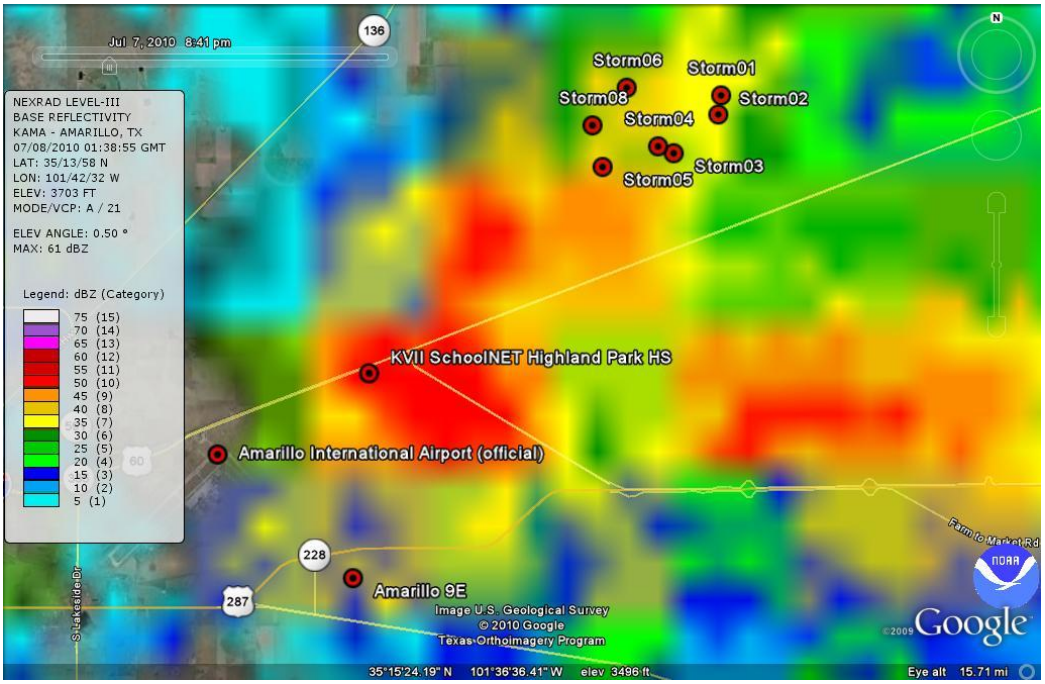


Figure 10: Base reflectivity radar data overlaid with reporting weather stations east of Amarillo at 838 PM CDT

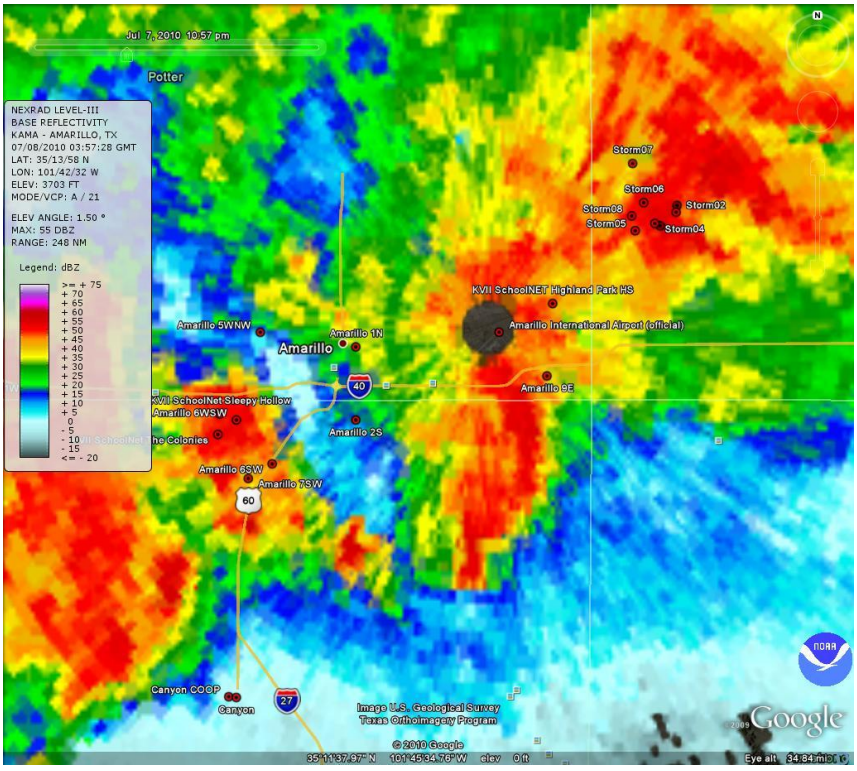


Figure 11: Base reflectivity radar data overlaid with reporting weather stations east of Amarillo at 1057 PM CDT.

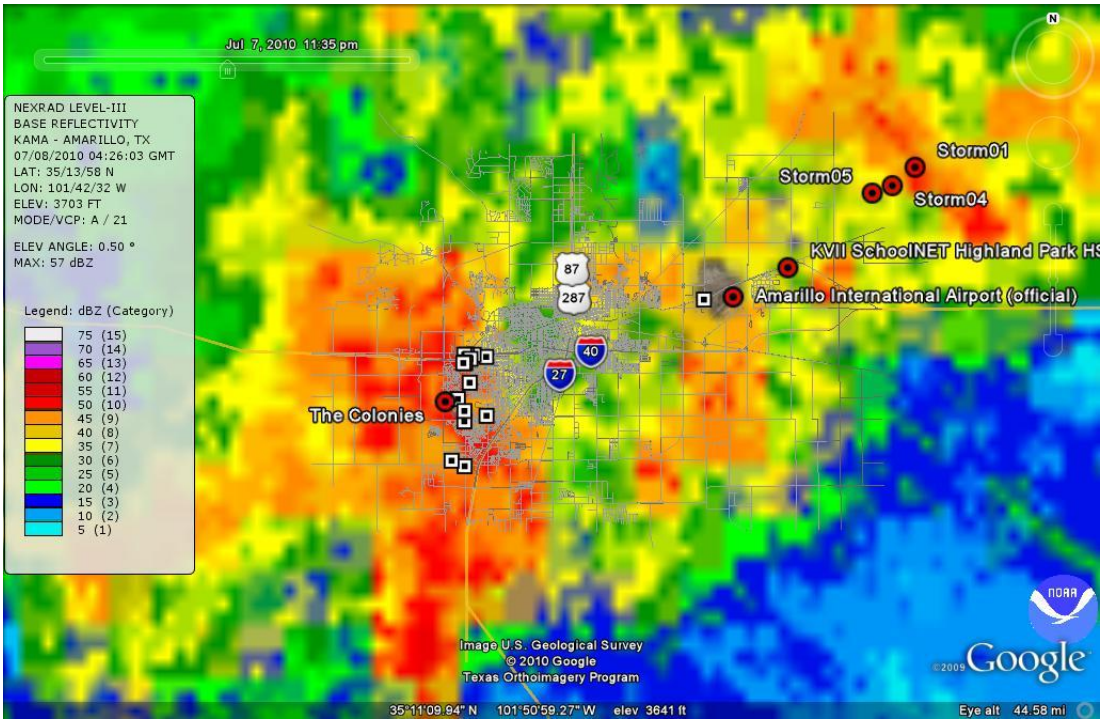


Figure 12: Base reflectivity at 11:26 PM CDT with swift water rescues (white squares) and reporting stations.

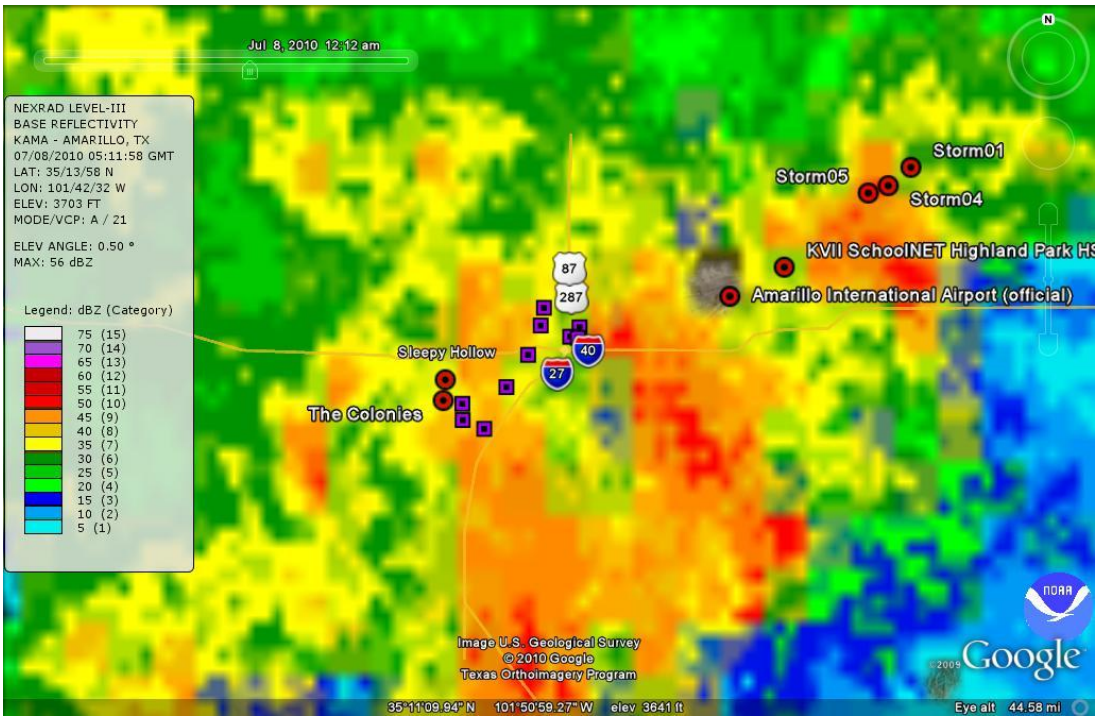


Figure 13: Base reflectivity at 12:11 PM CDT with swift water rescues (purple squares) and reporting stations.

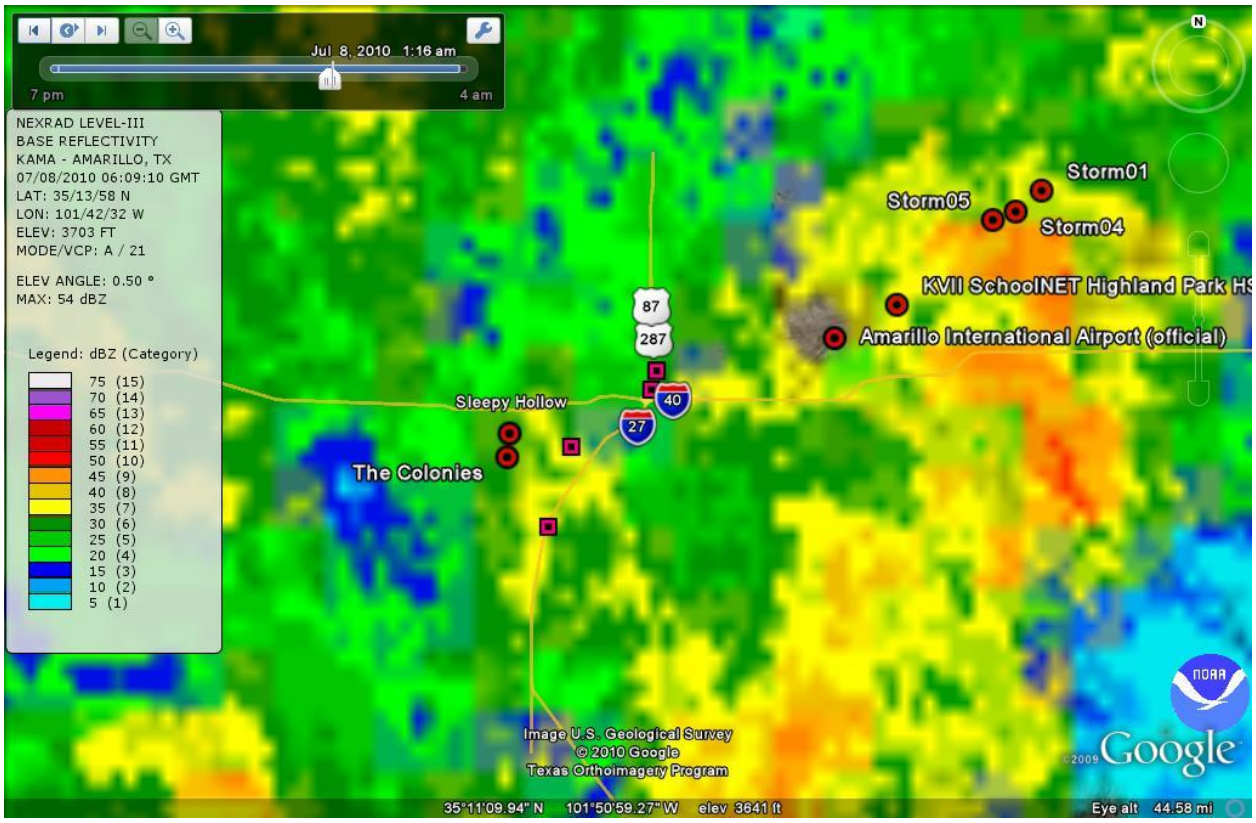


Figure 14: Base reflectivity at 1:09 PM CDT with swift water rescues (pink squares) and reporting stations.

Record	Previous Record
Record Rainfall - 5.74 inches	1960 – 1.78 inches
All Time Daily Maximum Rainfall Record - 5.74 inches	June 10, 1984 – 4.92 inches
Record Daily Rainfall for July - 5.74 inches	July 8, 1943 - 4.08 inches
Record 24-hr Rainfall - 7.25 inches	May 15-16, 1951 – 6.75
Record Monthly Rainfall (July 1-9) – 7.93 inches	July 1960 – 7.59 inches

Table 4: Records broken July 7-8 (NWS, 2010).

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.3	0.33	0.31	0.49	1.49	2	1.22	1.09	0.97	1.24	2.01	0.2
2	0.21	0.15	0.53	0.35	3.3	1.03	0.81	1.24	0.84	2.04	0.8	0.63
3	0.55	0.8	0.39	1.7	1.03	1.57	1.87	1.56	0.89	1.74	0.88	0.78
4	0.86	0.57	1.09	1.09	2.62	1.41	1.51	0.77	1.12	0.57	0.77	0.8
5	0.61	0.53	0.19	0.24	0.69	2.35	3.27	1.57	1.15	2.61	0.37	0.35
6	0.22	0.28	0.9	1.05	3.23	1.45	1.39	0.93	0.78	1.56	0.36	0.31
7	0.69	0.68	0.21	0.88	2.16	1.8	5.74	1.02	1.95	1.24	0.82	0.35
8	0.3	0.61	1.16	0.79	0.66	1.47	4.08	1.12	2.15	1.41	0.74	0.3
9	0.76	0.31	1.39	0.46	0.97	4.06	1.35	1.41	1.29	1.8	0.32	3.11
10	0.32	0.32	1.2	0.57	1.1	4.92	0.72	1.36	0.58	0.7	0.2	0.43
11	0.42	0.22	0.62	1.27	1.03	2.06	1.42	1.24	1.53	0.65	0.13	1.12
12	0.15	0.25	0.29	1.46	0.8	1.95	1.99	1.18	2.03	0.95	0.25	0.46
13	0.34	0.1	0.15	1.69	1.13	1.46	0.83	1.75	0.44	0.7	0.61	0.77
14	0.57	0.38	0.35	1.12	1.44	1.62	1.76	2.73	1.35	1.33	0.81	0.42
15	0.25	0.46	1.33	1.46	3.95	1.65	1.45	2.96	2.27	1.17	0.66	1.64
16	0.23	0.76	0.5	1.23	3.7	1.14	1.35	1.3	2.06	2.23	0.6	0.9
17	0.51	0.51	0.74	0.62	0.73	2.7	1.5	2.3	1.02	2.35	1.11	1.58
18	0.94	0.68	0.73	1.22	0.99	2.84	1.84	2.33	1.18	1.4	0.37	0.27
19	0.42	0.25	0.61	0.6	0.84	1.48	1.3	1.7	1.49	0.82	0.7	0.85
20	0.68	1.2	0.98	0.99	1.76	3.69	3.09	1.53	1.16	1.27	0.08	0.48
21	1.54	1.25	0.39	0.73	1.78	1.28	2.39	1.48	0.71	1.05	0.34	0.58
22	0.64	0.46	1.84	0.67	1.11	1.15	1.94	1.94	1.82	1.56	0.31	0.53
23	0.22	0.17	1.12	0.84	0.95	0.71	1.99	1.33	1.64	1.34	0.65	0.56
24	0.11	0.29	1.34	1.39	1.04	3.46	1.65	1.93	1.61	0.59	0.62	0.35
25	0.24	1.05	0.16	1.56	2.08	1.88	0.79	0.85	1.74	0.98	0.7	0.23
26	0.67	0.39	0.29	0.52	1.58	1.7	1.48	3.58	1.25	0.55	0.31	1.16
27	0.68	0.61	0.85	0.49	1.32	1.02	2.02	1.38	1.46	1.35	0.37	0.36
28	0.93	0.58	0.78	1.99	0.75	1.98	2.79	1.65	3.11	0.87	0.13	0.4
29	1.57	0.3	0.79	0.93	1.1	1.27	3.47	0.9	2.33	0.54	0.26	0.95
30	0.94	-	0.96	2.65	2.11	1.15	2.19	0.98	0.95	2.38	0.77	0.35
31	0.51	-	0.62	-	3.4	-	1.15	2.09	-	1.44	-	0.3

Table 5: Highest Daily Precipitation (inches).

Rick Husband Amarillo International Airport

The Rick Husband Amarillo International Airport received 7.33 inches of rainfall in total for the July 7-8 event. The facility's 9,400 square foot basement was completely flooded, inundating land-based phone and internet communications, electrical units, and heating and cooling systems. The airport remained in operation the following day via cell phones, radios, and internet cell cards. By late afternoon on July 8, the majority of the 18-20 feet of floodwater had been drained and pumped, making way for recovery and restoration efforts.

Figure 15 shows an aerial photo of the airport terminal taken in 2007. Additional development and construction is ongoing on the northwestern portion of the facility. To gain perspective, Figure 16 is a side view of the terminal with an open view of what the lower floor of the terminal looks like. As rainfall inundated the area, water flowed into the area behind the baggage claim, down the stairwells, and into the open area in the northwest portion of the terminal, eventually resulting in failure of a wide overhead door and allowing additional accumulating floodwaters into the basement. Pictures in Figure 17 show the water level behind the baggage claim area and the level flood waters rose in the stairwell down to the lower level.

Based on the measurements of the basement, calculations estimate a total of 1,316,320 gallons of water spilled into the basement. Analysis performed by City Engineer Martin Rodin show that this equals to about 189,362 Cubic Feet (CF) of storage. Over a 3-hour duration, it would take about 16 CFS of water flowing into the basement to fill that volume. City of Amarillo Deputy Aviation Director Pat Rhodes reported that by 11:10 PM the airport basement had filled to the top. As seen in Figure 8, rainfall rates at the airport surged from 10 PM – 12 AM going from a total of 0.28 inches to 4.75 inches. A normal 37' city street flowing gutter to gutter during a storm carries about 30 CFS. With water coming in from multiple directions at the airport, the 16 CFS was exceeded during the two to three hour maximum intensity.

Storm mains (blue lines) and inlet locations (green dots) were overlaid on aerial photos of the airport (Figure 18). A total of 5 inlets are located in the back of the terminal and 7 along the front area of the terminal. The storm sewer at the airport was designed in compliance with the Stormwater Management Criteria Manual for a 2-year storm for the Amarillo area (Stormwater Management Criteria Manual, 2010). Due to the magnitude and intensity of the rainfall, the storm sewer was probably at capacity within the first hour of runoff.

Research into the location of floodplains in the vicinity of airport reveal that the terminal was not located in a floodplain (Figure 19) nor are there any designations of surface ponding (AH). Surface ponding designations are areas subject to inundation by the 1% annual exceedance probability. Elevation data at various points around the terminal (Figure 20) show that terminal is a slightly lower point in relation to the area around it. Water flows from a high point to a low point, so water flowed from the both the rental parking lot and parking lot areas to the lowest point which ended up being the western part of the terminal with the opening to the basement. The flash flood event that occurred was very close to or may have exceeded a 100-year storm since the 24-hour rainfall for a 100-year event according to the Soil Conservation Service for Potter County is 6.5 inches. Mr. Rodin calculated that the

peak runoff (Q) generated by the 100-year storm over the airport drainage area would be 4807 CFS. The volume of runoff calculated would equal a small stream with nowhere to go but straight into the basement at the airport.

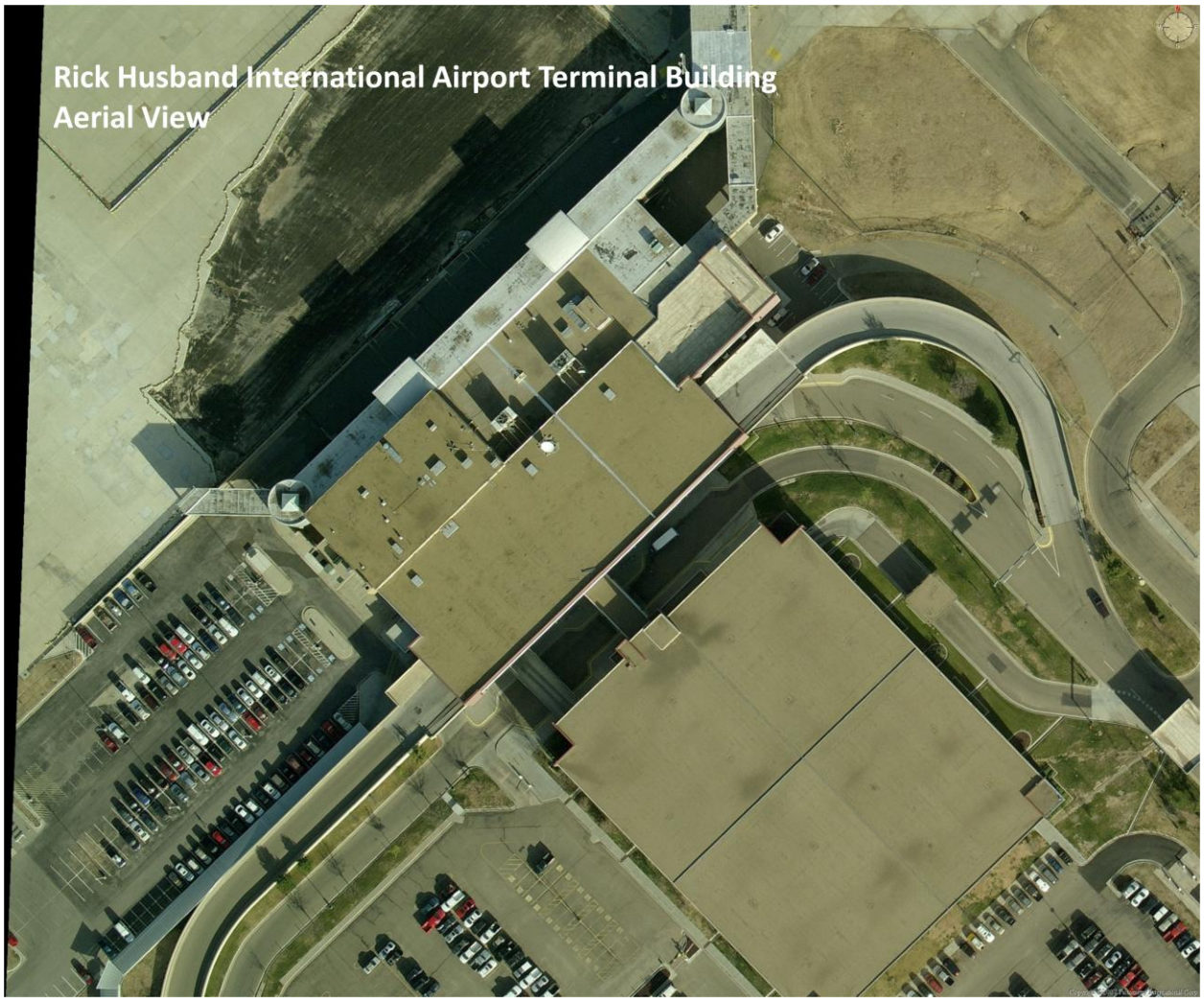


Figure 15: Aerial photo of the airport terminal.

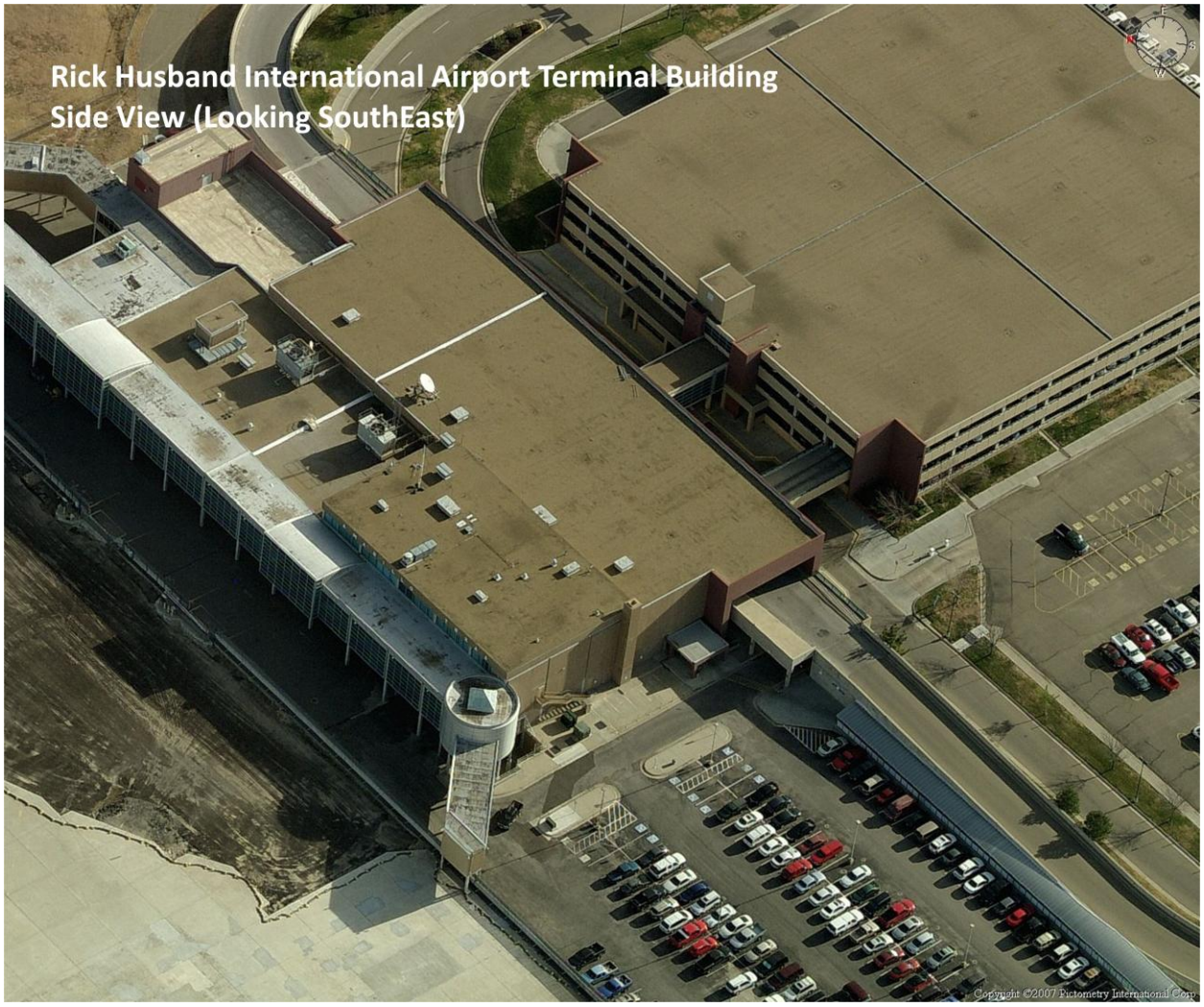


Figure 16: Oblique imagery of the airport terminal looking southeast.

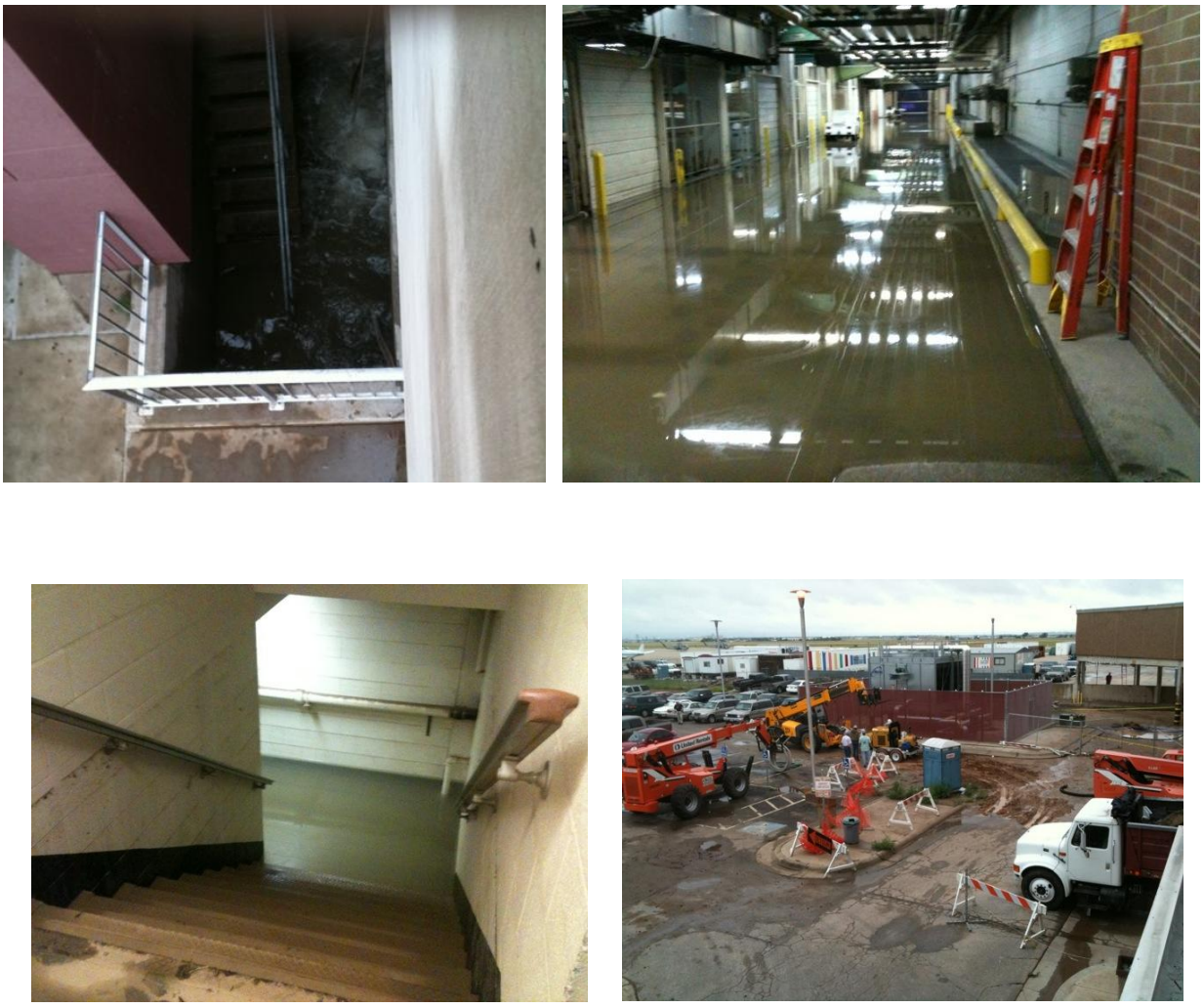


Figure 17: Pictures of the basement & behind the baggage claim area (Photos courtesy Daniel Blount).

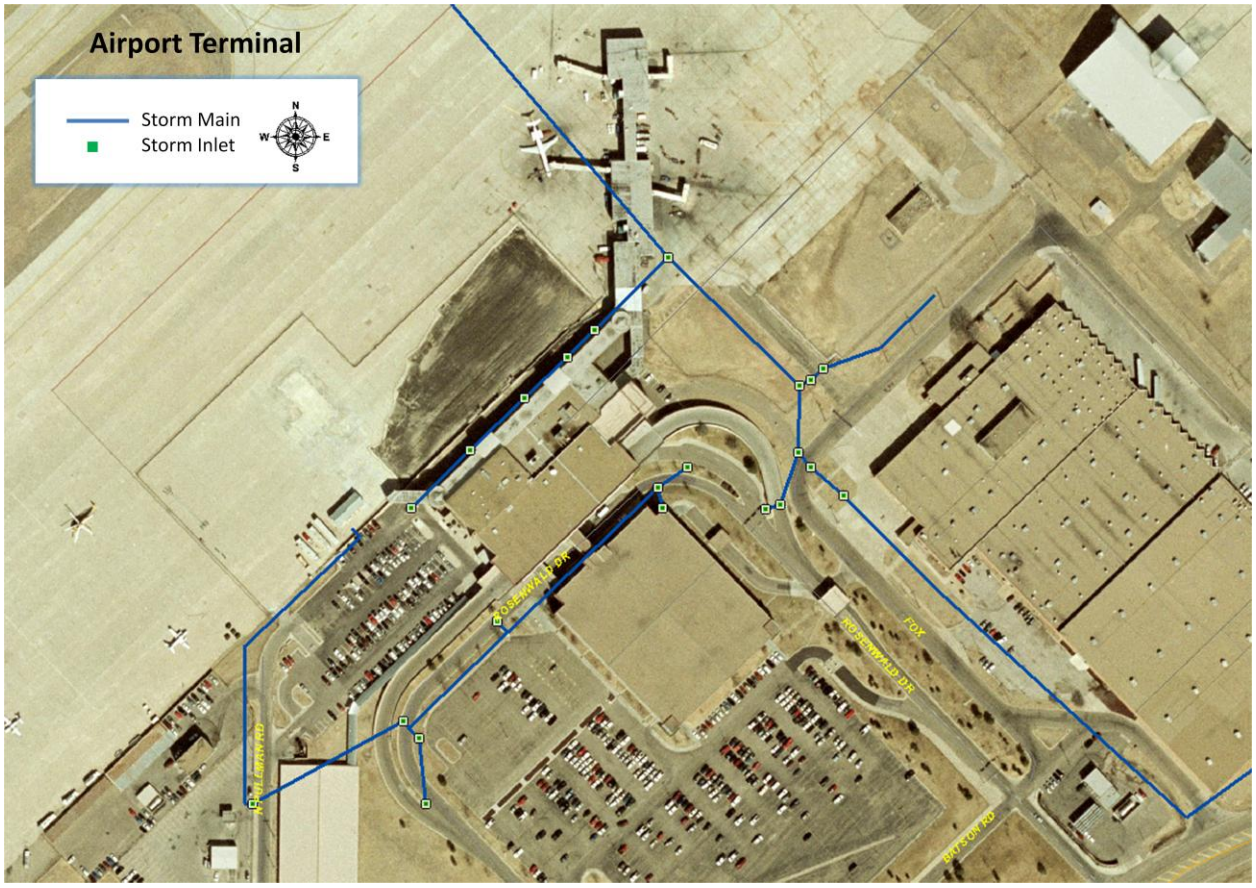


Figure 18: Aerial photo of the airport including storm mains and inlet overlays.

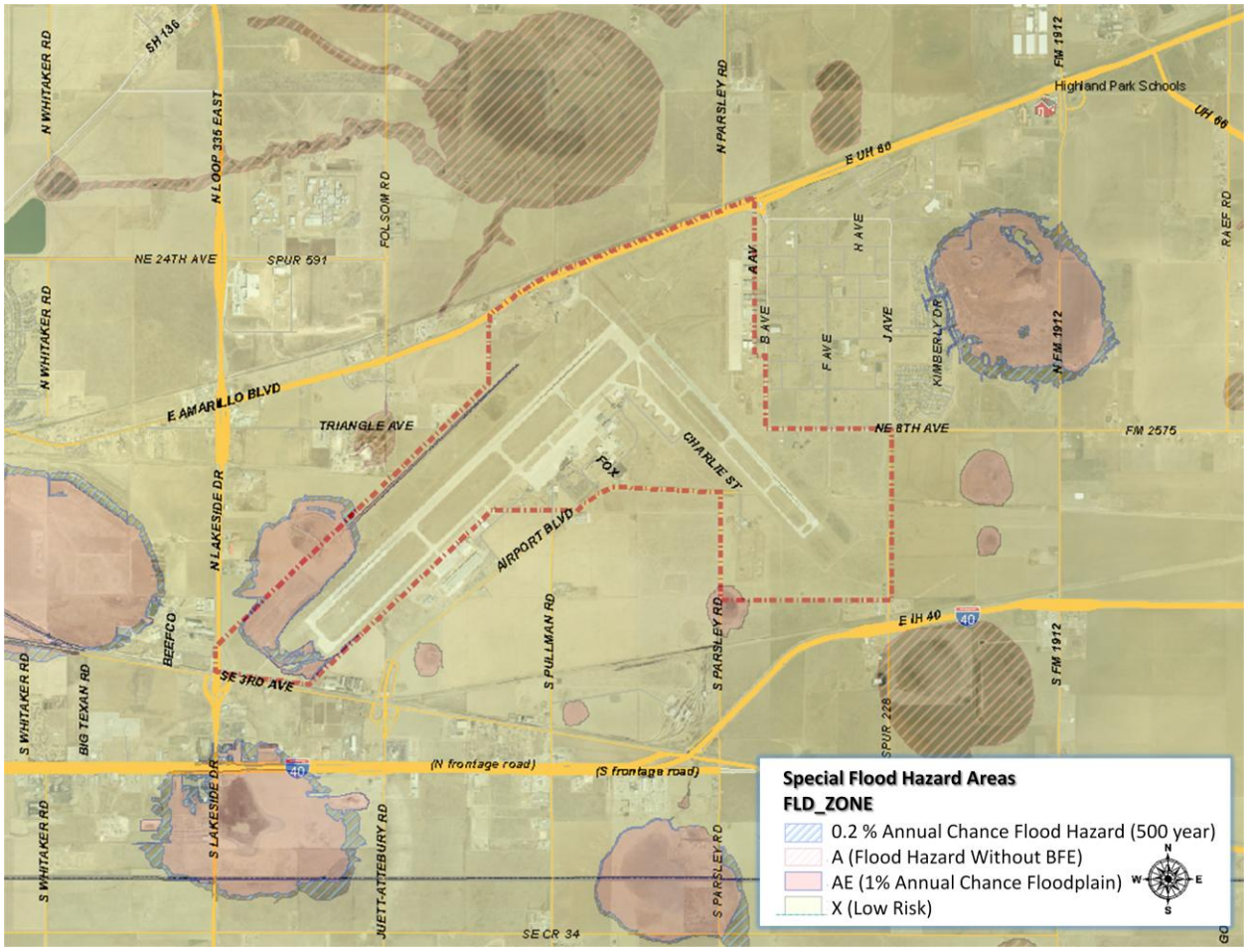


Figure 19: Floodplains within the vicinity of the airport.

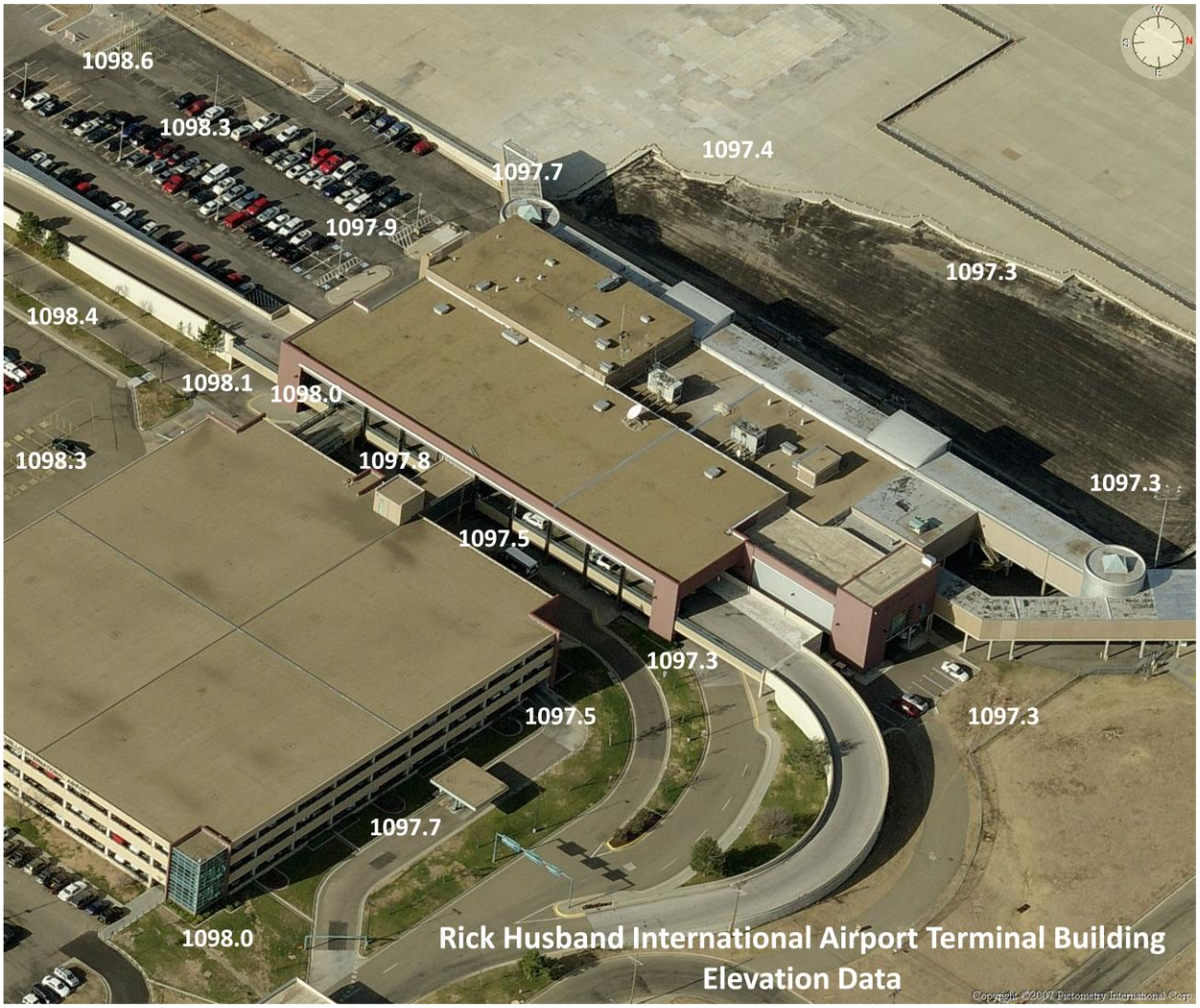


Figure 20: Airport elevation data (in meters).

Discussion/Conclusions

The July 7-8, 2010 event was analyzed from a meteorological, climatological, and engineering perspective. Based on this research, it can be concluded that:

- A combination of weak low level flow, a moist and unstable environment, and a stalled cold front that played contributing factors in slow moving convection behavior.
- During a 3 hour window (9PM – 12 AM), the Amarillo airport recorded a total of 4.78 inches of rainfall.
- The flash flooding event broke a total of 5 records, including the most rainfall experienced in a 24-hour period ever and was one of the worst flash flooding event for the Amarillo area.
- The observed 7.33 inches at the airport itself would make the 2010 flash flood event one of the top four highest rainfall flash flooding events in the Texas Panhandle region. The observed 11.04 inches at Highland Park School would rank it as one of the top flash flooding events in the Texas Panhandle region.
- Due to the magnitude and intensity of the rainfall, is probable that the storm sewer at the airport was at capacity within the first hour of runoff according to engineering calculations.
- The airport terminal was not located in a floodplain nor an area subjectable to surface ponding.

Rainfall intensity, rainfall durations, surface conditions, and topography and slope all are factors that contributed to flash flooding. Urbanization such as surface areas composed of impervious streets, roofs, and parking lots only exacerbate the flooding situation at the airport. Generally, this leads to greater and more rapid runoff volumes. Coupled with such great precipitation intensity, the ground, drainage systems, and sump pumps could not absorb and pump the water quickly enough, resulting in flooding in excess of any previous occurrence locally. Additional studies by Pantex using the Pantex weather station complex are also being completed and could add additional insight to this particular flash flood event.

Engineers use probabilistic estimates of rainfall intensities for particular durations and locations for the design of various structures including urban water drainage systems. Rainfall depth-Duration-Frequency data for Amarillo, Texas are outlined in the Storm Water Manual. However, this event broke all previous official weather records at a site where the data was used to generate the statistics in the first place. Albeit designing drainage systems for such extreme events is not practical, steps toward economically feasible mitigation measures should be considered.

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References

Heavy Rains Impact the Southern Texas Panhandle, 2010. Available online at [www.srh.noaa.gov/ama].

National Weather Service (NWS) - Amarillo, 2010. Available online at [http://www.weather.gov/climate/index.php?wfo=ama].

Storm Water Management Criteria Manual, 2010. Available online at [http://www.amarillo.gov/departments/engineering/pdf/Storm%20Water%20Mangement%20Criteria%20Manual%20031308.pdf].

Appendices

Appendix 1: Rick Husband Amarillo International Airport Surface Observation Station History

Please note that location information shown in the following records is for the Surface Observation Station, not the NEXRAD Radar Station. The Radar Station is located at the same site but may be some distance away at a different elevation.

Date Began	Date Ended	Lat/Lon	Elevation meters/feet	COOP ID	WBAN	Call Sign	WMO ID	Type
AMARILLO INTL AP								
17 Aug 2007	Present	35°08'N / 101°26'W	1098.5m / 3604'	410211	23047	AMA	72363	LAND SURFACE COOP AB ASOS ASOS-NWS NEXRAD
15 Mar 1994	17 Aug 2007	35°13'N / 101°42'W	1093.0m / '	410211	23047	AMA	72363	LAND SURFACE COOP AB ASOS ASOS-NWS NEXRAD
01 Nov 1992	15 Mar 1994	35°13'N / 101°42'W	1093.0m / 3586'	410211	23047	AMA	72363	LAND SURFACE COOP AB ASOS ASOS-NWS
28 Feb 1990	01 Nov 1992	35°14'N / 101°42'W	1093.0m / 3586'	410211	23047	AMA	72363	LAND SURFACE COOP AB WSO
01 Jun 1977	28 Feb 1990	35°14'N / 101°42'W	1098.5m / 3604'	410211	23047	AMA	72363	LAND SURFACE COOP AB WSO
AMARILLO AIR TERMINAL								
01 Jan 1975	01 Jun 1977	35°14'N / 101°42'W	1098.5m / 3604'	410211	23047	AMA	72363	LAND SURFACE COOP AB WSO
01 Jan 1973	01 Jan 1975	35°14'N / 101°42'W	1100.0m / 3609'	410211	23047	.	.	LAND SURFACE COOP WSO
01 Jan 1969	01 Jan 1973	35°14'N / 101°42'W	1100.0m / 3609'	410211	23047	.	.	LAND SURFACE COOP WBO
01 Jan 1950	01 Jan 1969	35°14'N / 101°42'W	1100.0m / 3609'	410211	23047	.	.	LAND SURFACE COOP WBAS

AMARILLO ENGLISH FLD								
31 Aug 1946	01 Jan 1950	35°14'N / 101°42'W	1100.0m / 3609'	410211	23047	.	.	LAND SURFACE COOP WBAS
01 Aug 1946	31 Aug 1946	35°14'N / 101°42'W	1100.0m / 3609'	410211	23047	.	.	LAND SURFACE COOP WBAS
01 Jan 1940	01 Aug 1946	35°14'N / 101°42'W	1100.0m / 3609'	.	23047	.	.	LAND SURFACE WBAS
01 Jan 1938	01 Jan 1940	35°14'N / 101°42'W	1101.9m / 3615'	.	23047	.	.	LAND SURFACE CAA
15 Dec 1937	01 Jan 1938	35°14'N / 101°42'W	1101.9m / 3615'	.	23047	.	.	LAND SURFACE WBAS
ENGLISH FLD								
01 Apr 1932	15 Dec 1937	35°14'N / 101°42'W	1101.9m / 3615'	.	23047	.	.	LAND SURFACE WBAS