

# FLASH FLOOD PREDICTION PROGRAM & RELATED ACTIVITIES

by  
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## ALERT System News

The District-operated ALERT gaging network continues to gain notoriety as it increases in size and more users become familiar with its capabilities. For example, Television Station KCNC (Channel 4) has purchased an ALERT base station and is collecting data directly from the air-waves. Many Denver area residents now know ALERT data as "RAINSCAN 4." Currently there are ten known points in the District which receive, decode and display data from 129 remote stations and 197 sensors. The table below summarizes the system status as of December, 1992.

Boulder County recently expanded their ALERT network by upgrading two sites to full weather stations. One of these sites is located in the Boulder Creek basin near Nederland and the other at Button Rock Reservoir on North St. Vrain Creek. This provides the Sheriff's Department with useful data (wind speed and direction, temperature, relative humidity, barometric pressure, precipitation) for controlling forest fires in the mountains.

The Bear Creek flood detection project, which was funded in 1989, is nearing completion. Permissions are still being sought for installations at a few remaining gage sites. The biggest improvement this year was finding the Choke Cherry Reservoir repeater site at Genesee which is capable of relaying radio signals from the most difficult mountain canyon stations. Special thanks to Don Van Wie of DIAD, Inc. (the District's ALERT system maintenance contractor) for identifying Choke Cherry as the best repeater site for Bear Creek and to Newt Free, District Manager, and the Board of the Genesee Water and Sanitation District for giving us permission to use this site.

Many software enhancements and creative applications continue to evolve at Denver area base stations. This is clearly a never-ending process and, as more computer-literate users begin experimenting with new ideas, the more we can expect to see in the future.

One of the more apparent improvements developed over the past two years is in the use of computer graphics and translated digital mapping from other GIS and

CADD systems (GIS: Geographic Information System, CADD: Computer Aided Drafting and Design). The following precipitation map (Figure 1) illustrates how digital mapping is used to enhance the presentation of ALERT data. Bruce Rindahl, design engineer with the City of Aurora, can be thanked for much of the initial development work.

Another example of graphics aided data interpretation is shown for an Arvada stream gage on Ralston Creek near Carr Street (Figure 2). This color display updates automatically as data is received and if studied closely, you will find 33 sensor readouts including: three hydrographs with variable time scales; one bar graph showing current water surface elevation; and 29 text readouts which provide basin rainfall data, stream stage and discharge at Carr Street; and upstream discharge measurements. Helpful flood information is also provided on the display and if a single picture is not adequate, the software is capable of "zooming" to another display. Similar templates are being developed for all stream gage points in the network.

A future flood detection project is anticipated for the Dutch Creek basin in southern Jefferson County, benefiting unincorporated areas and the Town of Columbine Valley. A planning study is also underway in Douglas County to complete a preliminary detection network design and evaluate potential benefits of implementing a county-wide system. The City of Aurora is looking at expanding their network to provide additional real-time data for water resources management. Creative alternative uses for ALERT data continue to evolve and requests for historic data are increasing. There is no question about it, the ALERT system is now serving the public in

ways that were never thought of when the first gaging network was installed for Boulder Creek in 1979. The District appreciates the contributions of the many dedicated individuals involved with this program.

## National Council Being Considered

The Southwestern Association of ALERT Systems (SAAS) and the ALERT Users Group (AUG), representing the western United States, hope to ratify an agreement in 1993 to form a policy advisory council of real-time data users to deal with issues of common interest on a national scale. Examples of such issues include: National Weather Service (NWS) modernization, NEXRAD implementation and related product dissemination, NWS policies concerning local government cooperators, federal allocations and regulations governing the use of hydrologic radio frequencies, flood warning program credit qualifications under FEMA's community rating system, warning programs related to dam safety, Corps of Engineers funded flood warning activities, and others. Initial members of the council will be comprised of selected leaders from the two ALERT users groups. Special steps are also being taken to include appropriate representation from the eastern United States.

The NWS has endorsed this idea at the highest levels. Lou Bouzi, Deputy Director in charge of NWS's Transition Program Office, has been identified as the council's contact at NWS headquarters in Silver Spring, Maryland. Local officials from around the country and many others involved with using real-time hydrologic and meteorologic data are encouraged by the willingness of NWS and other federal agencies to allow us to have a voice in matters which will eventually impact our programs.

CURRENT ALERT SYSTEM STATUS:				
NETWORK	STATIONS	PRECIP	STAGE	WEATHER SENSORS
District Wide	12	10	10	4 (1 station)
S. Platte & MP	4	3	3	
Lena Gulch	9	6	3	
Ralston Creek	13	12	8	4 (1 station)
Westerly Creek	10	10	6	
Toll Gate Creek	11	11	8	6 (1 station)
Goldsmith/Harvard	5	5	4	4 (1 station)
Bear Creek	12	11	6	
Boulder County	53	41	12	10 (2 stations)
TOTALS	129	(109)	+ (60)	+ (28) = 197 SENSORS

**New Flood Warning Plans**

New flood warning plans were released this year for Bear Creek in Jefferson County and Toll Gate Creek in Aurora. The Boulder Creek plan, first written in 1979, was completely re-written in 1992 by including South Boulder Creek and the tributary streams which impact the City of Boulder most heavily. All seven flood warning plans currently in effect have similar formats and will continue to be updated and exercised annually by the District. Upon request, the District also assists local governments with their routine updating of local emergency operations plans and incident command manuals. All District plans are identified as flood annexes or technical appendices to local emergency plans.

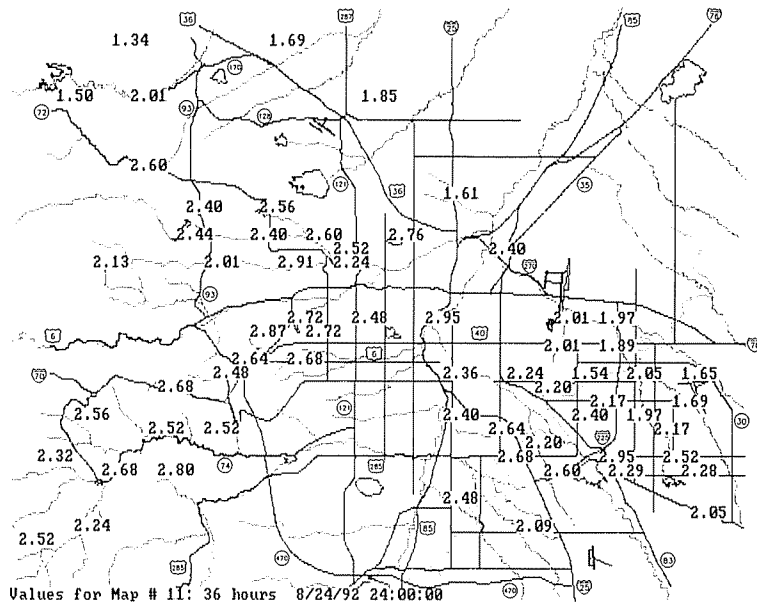
**Significant Hydrologic Events**

The 1992 flood season produced only a few marginally exciting days with the total number of "Message Days" being slightly less than average. April and May passed without any messages being issued. The summer months of June, July and August brought us 29 message days with monthly totals of 11, 10 and 8 respectively. For the first time in the 14-year history of the program, no messages were issued in September. The following days highlight the more notable hydrologic events of 1992:

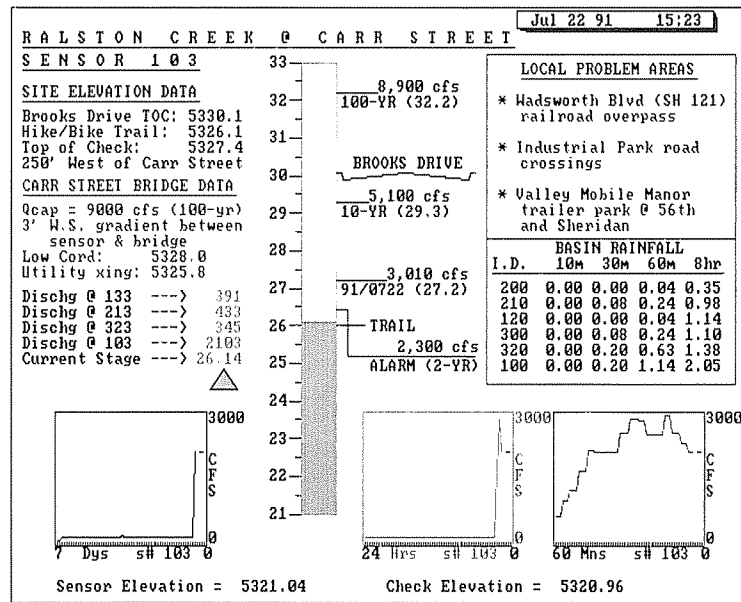
**June 6:** It seems like every year, the first week in June can be counted on for something interesting to occur weather-wise. This typical Saturday afternoon won the honors as the first message day of the year, producing a thunderstorm in Aurora that dumped approximately one-inch of rain in 40 minutes between 5:00 and 6:00 p.m. The heaviest rainfall measured by the ALERT system occurred at the Granby Ditch gage near 6th Avenue and Buckley Road. No major flood problems were reported. The stream gage on Sand Creek below I-225 measured its annual peak at 7:18 p.m.

The Henz Meteorological Services (HMS) 3:45 p.m. forecast indicated rainfall amounts just below flood potential and therefore, messages were not issued at that time. As the situation changed, messages were later issued for Arapahoe and Douglas Counties, including the City of Aurora. This event was of sufficient magnitude to prompt the NWS, at 5:45 p.m., to issue an urban and small stream flood advisory effective until 6:45 p.m.

The Westerly Creek basin experienced enough runoff to cause



**Figure 1. Thirty-six hour rainfall depths for the Denver area on August 24-25.**



**Figure 2. Sensor readouts for the Ralston Creek at Carr St. gage site.**



**Figure 3. I-25 at Evans Ave. on July 20, 1992.**

water in the Expo Park detention basin to rise four feet. An interesting point about this is that it took almost two days for the pond to drain due to a plugged outlet. The ALERT stage gage at Expo Park provided an excellent record of this incident.

**July 15:** Aurora's turn again! This time it was a Wednesday at the beginning of the hurry-home rush between 4:00 and 6:00 p.m. with the heaviest measured rainfall occurring east of I-225 in the Toll Gate Creek drainage basin. The Sable Ditch ALERT gage near 18th and Chambers received 1.54" of rain over a 75-minute period with nearly an inch occurring in 30-minutes. Aurora street crews were mobilized and preparing for problems by 4:00 p.m. HMS messages were issued for Aurora at 3:32 p.m. The NWS had a severe thunderstorm warning in effect for SW Adams and NW Arapahoe Counties at 3:40 p.m. and flood advisories were issued for Aurora by 4:40 p.m.

On July 17, a highwater survey was performed for the District by Leonard Rice Consulting Water Engineers, Inc. of Denver. This type of activity is routine for the District in documenting flood events, but in recent years, more emphasis has been placed on verifying the performance of stream gages. This gives us added knowledge about rainfall/runoff processes in the Denver area, permits us to further refine hydrologic models, and improves our capability to detect and predict of floods with greater lead-time for warning.

Annual peaks were measured on this day at the following Aurora gage sites:

- Sable Ditch at 18th Ave.
- Westerly Creek basin at 11th & Havana.
- West Toll Gate Cr below Mexico.
- East Toll Gate Cr at Buckley Rd.
- Toll Gate Creek at 6th Ave.
- Granby Ditch at 6th Ave.

**July 20:** This Monday afternoon produced the most intense measured rainfall of the year in Denver causing a closure of I-25 at Evans from reported 4-foot water depths on the freeway (Figure 3). As usual, the storm waited for the evening rush-hour to begin with the peak rainfall occurring between 4:00 and 5:00 p.m. The storms on this day were small in size and short-lived, lasting generally no more than 30 minutes. However, those 30 minutes were quite impressive at some locations. The Harvard Gulch ALERT station at Jackson Street, located northwest of

the Yale Ave.-Colorado Blvd. intersection, is the nearest automated rain gage to where the I-25 flood problem occurred. This station measured a total amount of 1.50" in 28 minutes beginning at 4:13 p.m. with a peak 5-minute intensity of 5.4 in/hr. This intense 5-minute period has a calculated rainfall frequency of 10-years. The most intense short-duration rainfall measured on this day was at the Virginia Court gage in Aurora where a 5-minute intensity of 7.2 in/hr (~25-year frequency) was recorded.

By 3:30 p.m. internal alert messages had been issued for NE Jefferson, western Adams, western Arapahoe and Denver Counties valid from 4:00 to 9:00 p.m. Forecast rainfall was estimated to reach 0.75" to 1.50" and last 30 to 45 minutes. A tornado watch was also in effect for the entire District. The NWS extended an urban and small stream flood advisory at 4:53 p.m. reporting flooded road conditions on I-25 and near Iliff and Chambers in Aurora.

Annual peaks were measured on this day at the following Denver gage sites:

- Harvard Gulch at Jackson St.
- Harvard Gulch at Logan St.

**August 24:** Beginning shortly after noon on Sunday, August 23, 2 to 3 inches of rain proceeded to fall over the next 36-hours making this period the most significant area-wide hydrologic event of 1992 (see Figure 1). While the runoff volume was high due to the large area affected, rainfall intensities never reached 1.0 in/hr alarm levels and the flash flood potential remained relatively low all day. The most intense hourly rainfall measured by the ALERT system occurred in Boulder at the Boulder County Justice Center, at 6th Street and Canyon Blvd., where 0.6 inches fell between 5:00 and 6:00 a.m. For most areas, hourly rainfall amounts averaged one-quarter inch or less.

Weather forecasts and reports were continually updated throughout the day. The main heavy precipitation concern involved the remnants of a Pacific hurricane which approached the District from the southwest. The eye of the hurricane was apparent on satellite photos and passed just south of the District over Douglas County continuing its northeasterly movement over Bennett, Colorado, missing the metropolitan area of Denver. Local officials were kept continually advised of this situation. The NWS issued a flash flood watch on August 24 at 5:45 a.m. which

expired at 9:00 p.m. NWS and HMS meteorologists remained in constant contact, demonstrating excellent coordination. A flood advisory was issued for the Denver area at 2:30 p.m. due to rainfall cumulations exceeding two inches at many locations.

Annual peaks were measured on this day at many stream gages throughout the Denver metropolitan area. The most note-worthy discharges occurred on the South Platte River. The Henderson gage peaked at 8:15 p.m. with a discharge of 11,770 cfs, which is slightly less than a 10-year flood event. Many other tributary streams such as; Bear Creek, Cherry Creek, Sand Creek and Clear Creek, were also running much higher than normal but their peak flows generally did not exceed a 2-year flood frequency. Some minor records were also set, like at the Englewood Dam ALERT gage in Arapahoe County which measured its highest water level since installation in 1987.

The flood problems that did occur were anticipated and the public was well informed by television and radio stations. The biggest reported problems involved drainage related traffic hassles at known trouble spots but the river rafters had a great time.

This concludes our discussion of what we have identified as the most significant hydrologic events of the year for the District based on measured rainfall and streamflow data and some eye-witness reports. We would appreciate hearing from readers who may be aware of other flood days and receiving any documentation that may be available. Anyone interested in more specific ALERT rainfall or streamflow data should contact the District.

#### **NEXRAD Is Coming To Denver**

Larry Mooney, Area Manager at the Denver National Weather Service Forecast Office, has indicated that Denver's NEXRAD radar is scheduled for an April, 1993, delivery. The new Doppler radar will be located near Watkins, Colorado, and is expected to be turned on by mid-summer. Use of the existing radar at Limon will eventually be discontinued. This project is one component of NWS's nationwide modernization plan involving replacement of all existing weather surveillance radars, many of which utilize 1950's technology. In addition to providing much higher-resolution imagery, the new Doppler radars have many other capabilities as illustrated by Figure 4.

The District has taken steps to prepare for the arrival of NEXRAD. A radar options study was completed in 1992 which recommends utilizing the District's existing satellite downlink receiver and purchasing a Kavouras RADAC 2100 computer to display the new radar products. In addition, the RADAC 2100 is capable of displaying satellite pictures and data from other surrounding radars, including Limon. Other users currently sharing the District's dedicated phone line from Limon must now consider alternatives for obtaining live radar. The options study suggests some possibilities but each organization must consider their own requirements. The District does not intend to leave anyone hanging and will keep each group informed regarding decisions that may affect them. Change always offers many new challenges, but the first question for many government agencies will likely be: Are the acceptable alternatives affordable?

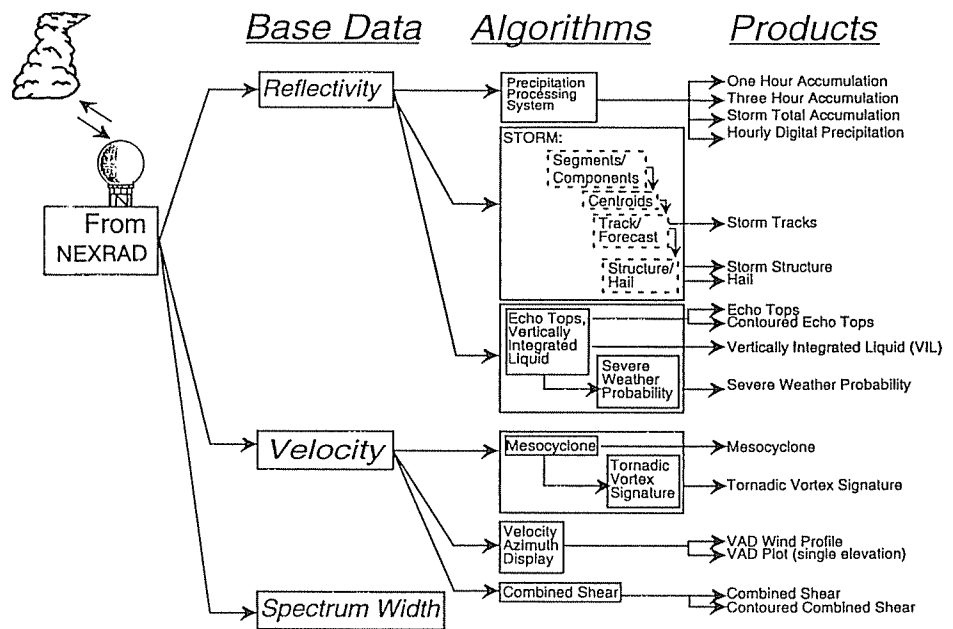


Figure 4. NEXRAD Capabilities.

**Tucker (from page 3)** contact these cities for additional information.

**The Water Pollution Control Act - It Is Time For A Change**

On a somewhat different but related issue, I have begun to question the soundness of the basic premise of the Water Pollution Control Act (WPCA). The WPCA was originally passed in 1972 and constituted a dramatic commitment of the nation to clean up our rivers, lakes, streams and wetlands. Strong language was needed as well as lofty goals because water pollution was a problem and there was a long way to go. Because of the WPCA, the U.S. has made significant improvements to water quality, but as obvious problems are addressed emphasis is shifting to other pollutant sources where benefits will not be so apparent and easily identified.

My concern is with the first sentence of the WPCA which states that "The objective of this Act is to restore and maintain the chemical, physical and biological integrity of the nation's waters." Taken literally, the word, "restore" is troubling. Water quality is critical to developing usable, attractive and safe urban stream corridors but it is unrealistic to think in terms of "restoring" the chemical, physical and biological integrity of developed urban stream corridors now existing in our urban

metropolitan areas. Again, taken literally, it is a stated objective of the nation to return these stream corridors to a condition that predates settlement. This is not a realistic objective and not the right objective. The clock cannot be turned back to pre-settlement times.

Realistically, it is even difficult to apply specific criteria to such goals as biological integrity. For example, the State of Colorado is considering the adoption of biological criteria as water quality standards. The Water Quality Division staff concluded that biological criteria should not be adopted as Water Quality Standards at this time. Among other reasons, they cite the lack of data for streams in Colorado that can be used for specifying appropriate "reference reaches" or assessing the comparative biological integrity of impacted streams. They also note that it is extremely difficult to find unimpacted reference waters for the water bodies and habitat types which are commonly affected by point source discharges in Colorado.

It is time to reassess the goals of the WPCA and bring them closer to reality. Good water quality must remain a high priority and good water quality is an important and necessary component of a viable urban stream corridor. However, urban stream corridors have a unique value in an urban context and provide important character to the urban environment

and they need to be preserved and enhanced for what they are. It is not practical to think in terms of restoring the physical, chemical and biological integrity to some predevelopment condition. They are forever changed.

**Coal Creek Trail**

Another segment of the Coal Creek trail, a joint recreation and maintenance access project, was completed in 1992. This section is located in Lafayette, and connects to a segment of trail constructed through Louisville Open Space and dedicated the same day. This segment was funded by Lafayette, Boulder County and the District.



Boulder County Commissioner Ron Stewart (right) and Lafayette Mayor Larry Gupton cut the ribbon officially opening the trail.