

THE DAVIS COUNTY FLOOD WARNING AND INFORMATION SYSTEM

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Mike Lowe, S.R. Williams, and S.W. Smith

March, 1989

Utah Geological and Mineral Survey

Open-File Report 151

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SID SMITH  
Director

# Davis County

# FLOOD CONTROL

The Davis County Flood Warning and Information System

July 26, 1988

by

Mike Lowe, Scott R. Williams, and Sidney W. Smith

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## Introduction

Extensive damage occurred in Davis County in 1983 and 1984 due to flooding and debris-flow events. As a result of these recent hazard events, Davis County has taken a number of steps to reduce the future impact of flooding and debris flows. These steps include stream-channel improvements and construction of debris basins, detention ponds, and large open and piped storm drains. Areas still exist in Davis County which are at risk from future floods and debris flows, however. In some areas, debris basins and detention ponds have not yet been constructed. Some canyons still pose a threat to downstream residents because of past development which is too close to stream channels. Also, there is always the threat of an extremely large debris-flow event or super storm (greater than 100-year event) which could exceed design criteria for debris-flow and flood-control structures. To compliment Davis County's efforts to mitigate flooding and debris-flow hazards, a Flood Warning and Information System (ALERT) has been established which can be used to provide early warning of potential hazard events. This early warning can be used both to alert the public of impending danger, and to make decisions regarding emergency crew deployment. Besides early warning, the ALERT system is designed to

provide accurate real-time information to be used in the prediction and control of weather-initiated events such as flooding, landsliding, and debris flows. This information can be used as a basis for future flood and debris-flow control design and master planning. The ALERT system was partially funded by a grant from the Utah Geological and Mineral Survey.

### Alluvial-Fan Hazards

The eastern portion of Davis County is particularly susceptible to hazards associated with alluvial-fan deposition because of the steep mountains and the weathering characteristics of the bedrock unit in the mountains (the Precambrian Farmington Canyon Complex) which provides much unstable hillside debris. Several forms of alluvial-fan deposition provide hazards to development on or below alluvial fans. Debris flows, transitional flows, hyperconcentrated sediment flows, clear-water flooding, and normal streamflow form a continuum of sediment/water mixtures that grade into each other as the relative proportion of sediment to water changes and as stream gradient changes. Deposition of sediment transported by processes associated with these types of alluvial-fan sedimentation events primarily takes place on alluvial fans at canyon mouths. This deposition is caused by the decrease in channel gradient and increase in channel area, resulting in a decrease depth

and velocity of flow and an increase in internal friction of the flowing debris as the stream leaves its constricted channel and enters the main valley floor (Jochim, 1986). Clear-water flooding may continue to be a problem well downstream of the distal alluvial-fan boundary.

Debris flows are mixtures of rock material (70-90%) and water that form a muddy slurry much like wet concrete, and flow downslope due to gravity. Debris flows remain confined to stream channels in mountain areas, but may reach and deposit debris over large areas on alluvial fans at canyon mouths. Debris flows are a hazard which principally affect proximal fan areas (Keaton and others, 1988). Debris flows have occurred often in Davis County during historical time and have caused damage to property and loss of life (table 1).

Debris flows can form in at least two different ways. In mountainous eastern Davis County, where cloudburst rainstorms are common, overland flow and flood waters can scour materials from the ground surface and from the stream channel, thereby increasing the proportion of soil materials to water until the mixture becomes a debris flow (Wieczorek and others, 1983). The size and frequency of debris-flow events generated by rainfall are dependent upon several factors including the amount of loose material available for transport, the magnitude and frequency of storms, amount and type of vegetative cover, and the antecedent moisture content of the soil. Debris flows during the 1920s and 1930s in Davis County were generated by summer cloudburst storms.

Table 1. Historical Davis County debris flows (Marsell, 1972; Wiczorek and others, 1983; U.S. Army Corps of Engineers, 1984; Davis County Flood Control, 1987).

<u>DRAINAGE</u>	<u>YEARS</u>	<u>REPORTED DAMAGE OR LOSS OF LIFE</u>
Dry Fork, Kays Creek	1984	house damaged.
Middle Fork, Kays Creek	1947, 1953	
South Fork, Kays Creek	1912, 1923, 1927, 1945, 1947	
North Fork, Holmes Creek	1983	
South Fork, Holmes Creek	1917	
Baer Creek	1983	
Shepard Creek	1923, 1930, 1983	
Farmington Creek	1878, 1923, 1926, 1930, 1947, 1983	1923 - 7 deaths, several houses damaged.
Rudd Creek	1983, 1984	1983 - 35 houses damaged, 15 severely.
Steed Creek	1923	
Davis Creek	1878, 1901, 1923	
Ricks Creek	1923, 1929, 1930	1923 - 1 house damaged, 1930 - 1 house damaged.
Parrish Creek	1930 (several events)	several houses destroyed, school damaged.
Stone Creek	1983	houses damaged.
Mill Creek	1983	

Debris flows can also mobilize directly from debris slides. A debris slide is a type of landslide in which the material involved is predominantly coarse-grained debris, chiefly colluvium. A debris flow may be generated when the debris slide reaches a flowing stream, or when the water content in the debris slide is sufficient to permit flow. Debris flows during the springs of 1983 and 1984 in Davis County were generated by debris slides caused by rapid melting of an unusually thick snowpack.

As the relative proportion of water to sediment increases, debris flows become transitional flows. Transitional flows present hazards which principally affect proximal and medial fan areas (Keaton and others, 1988). With the addition of even more water (or removal of sediment), transitional flows become hyperconcentrated sediment flows. Hyperconcentrated flows are often referred to as debris floods, mud floods, or mud flows. In hyperconcentrated sediment flows, soil materials are transported by fast-moving flood waters (Wieczorek and others, 1983). Solids account for 40% to 70% of the material by weight. These flows can originate either by progressive incorporation of materials into flood waters or by dilution of debris flows (Wieczorek and others, 1983). Hyperconcentrated sediment flows are a hazard even to the distal portions of alluvial fans (Keaton and others, 1988). There is no adequate record of historical hyperconcentrated sediment-flow events in Davis County, but it is likely that

hyperconcentrated sediment-flow events have occurred more frequently than debris flows

In clear-water flooding, solids account for less than 40% of the water/sediment mixture by weight. Snowmelt-induced floods are the most common type of flood which may occur in Davis County. Floods of this type are somewhat predictable and depend on the volume of snow in the mountains and the rate of temperature increase in the spring. Snowmelt flooding in Davis County is a nearly annual event and abnormally high snowmelt floods occurred in Davis County in 1922, 1952, 1983, and 1984.

Summer cloudburst floods account for more localized but often very destructive flooding and can occur with little warning. Unlike snowmelt floods, the intensity and flooding potential of cloudburst rainstorms aren't known until rain is actually falling on critical areas. This can mean that the time for prevention is passed. Farmer and Fletcher (1971; 1972) have shown that in over 30% of storms more than 70% of the total precipitation occurred in the first 27% of the storms duration. This means that for the first few minutes of the average short duration (two-hour or less) storm, the rainfall intensity can be extreme, possibly far exceeding the potential infiltration rates of soils or the carrying capacity of local storm drain systems. Davis county experience 39 cloudburst floods between 1850 and 1969 (Butler and Marsell, 1972).

## Wind Hazards

Davis County is located in an air basin which is formed by the mountains which border the Great Salt Lake. A unique, low velocity wind, termed the local wind circulation (LWC), generally dominates the movement of air in the Great Salt Lake basin (Wasatch Front Regional Council, 1980). The LWC is caused by uneven heating and cooling of land and water areas in the air basin. This is a diurnal wind which tends to blow upslope off the Great Salt Lake in daytime and downslope towards the lake at night (Wasatch Front Regional Council, 1980). Wind velocities associated with the LWC in the downslope direction are nearly equal in all seasons, but wind velocities associated with the LWC in the upslope direction are highest in the spring and summer seasons, because heating is strongest in these seasons (Wasatch Front Regional Council, 1980). In the daytime, especially in the summer, the LWC often carries moisture evaporated from the Great Salt Lake upslope into the mountains where cooler air causes the moisture to return to the ground as precipitation. Wind velocities associated with the LWC generally do not exceed 10 mph, except for limited periods in some Great Salt Lake and canyon mouth areas (Wasatch Front Regional Council, 1980). Passing storms and large-scale weather systems cause higher winds, with wind gusts sometimes exceeding 100 mph in velocity. Although winds which are not associated with the LWC are short in duration and occur only about 20 percent of the total time (Wasatch Front Regional Council, 1980), they

are of major concern in Davis County where trains and motor vehicles have been blown over in the past and wind damage to property is a nearly annual occurrence.

Potential uses of the Flood Warning and Information System

Some of the potential uses of the Flood Warning and Information System (ALERT) are to provide information for: 1) assessment of the flood causing potential of an approaching storm before it reaches critical areas by real-time intensity interpretation; 2) accurate prediction of the path of a storm through differential comparison of weather station sites; 3) timely alert of residents, local officials, and emergency services personnel during potentially hazardous rain storms or periods of high wind velocities; 4) the prompt dispatch of emergency maintenance crews to areas where culverts, grates, detention ponds, and debris basins may require work during the storm event; 5) identification of sudden decreases in stream flow, which may indicate that landsliding upstream of the weather station has blocked the channel and debris-flow hazard is high; 6) monitoring movement on critical landslides; 7) monitoring soil moisture conditions during spring snowmelt and rainy seasons; 8) monitoring flow levels in debris basins, detention ponds, and storm drains; and 9) to supplement the existing data base of information concerning weather events so that better land-use planning and appropriate levels of mitigation will occur in

potentially hazardous areas.

### Flood Warning and Information System Design

The Davis County Flood Warning and Information System currently consists of 12 real-time automatically reporting gaging stations supplied by Sierra Misco, Inc., of Berkely, California, and installed by HHI, of Farmington, Utah, at sites throughout the county (figure 1; table 2). Each station consists of a transmitter and several types of gages. The type of gage or monitoring instrument installed depends upon the location and purpose of the individual weather station. The types of monitoring instruments currently in use include: stream gages (float gage or pressure transducer), precipitation gages, wind sensors, piezometers (pressure transducer), and extensometers (to measure landslide movement). Other types of instruments, such as water-quality monitors, are available and could be added to the system if the need arises. Data from each ALERT station is reported via radio transmission to three computers which record readings on a continuous basis. Two computers share a radio reciever and are located in the Davis County Flood Control and Davis County Sheriff's offices in Farmington, Utah. The third computer is located at the National Weather Service in Salt Lake City, Utah. As some of the ALERT stations are not capable of line-of-sight radio transmission to all computer sites, a repeater has been located just north of Antelope Peak on Antelope Island in the Great Salt Lake.

Figure 1. Location map for Davis County weather stations.

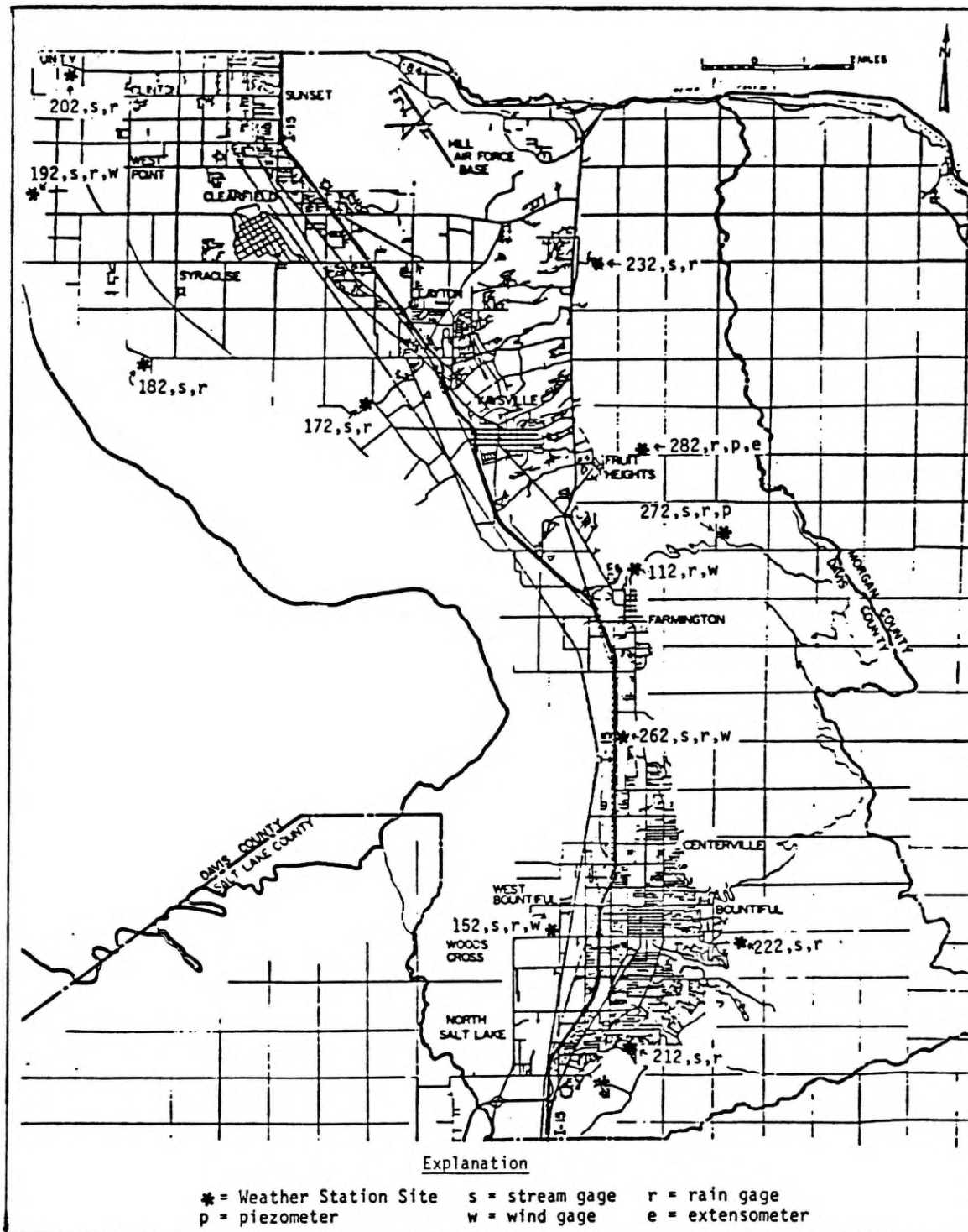


Table 2. Davis County Flood Warning and Information System Stations, 1988.

REPORT GROUP	LOCATION	ALERT SYSTEM SENSOR IDENTIFICATION NUMBER AND FUNCTION
South Davis	3550 S. Davis Blvd., Bountiful	212-Float Gage - liquid level (Hooper Draw stream) 213-Tipping Bucket - rain gage 216-Pressure Transducer - liquid level (Hooper Draw debris basin)
	95 N. 1100 W. West Bountiful	152-Float Gage - liquid level (Mill Creek stream) 153-Tipping Bucket - rain gage 150-Anemometer and Vane - wind velocity and direction sensor
	1500 N. Frontage Road, Centerville	262-Float Gage - liquid level (Dicks Creek stream) 263-Tipping Bucket - rain gage 260-Anemometer and Vane - wind velocity and direction sensor
	600 S. Bountiful Blvd., Bountiful	222-Float Gage - liquid level (Barton Creek stream) 223-Tipping Bucket - rain gage 226-Pressure Transducer - liquid level (Barton Creek debris basin)
Central Davis	U.S.U. Station, Farmington	115-Tipping Bucket - rain gage 112-Anemometer and Vane - wind velocity and direction sensor
	3000 W. Gentile, Syracuse	182-Float Gage - liquid level (Syracuse South storm drain) 183-Tipping Bucket - rain gage
	*Halfway Creek, Skyline Drive, Farmington Canyon	272-Float Gage - liquid level (Halfway Creek stream) 273-Tipping Bucket - rain gage 276-Pressure Transducer - piezometer
	*landslide # Dsa516/ Fruit Heights culinary Spring, south side Baer Canyon	282-Float Gage - extensometer (landslide east of spring) 283-Tipping Bucket - rain gage 286-Pressure Transducer - piezometer

Table 2 - continued

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North Davis	600 S. Angle Street, Kaysville	172-Float Gage - liquid level (Kayscreek, after forks join) 173-Tipping Bucket - rain gage 176-Pressure Transducer - liquid level (Fill Field storm drain)
	200 South, West Point	192-Float Gage - liquid level (Howard Slough) 193-Tipping Bucket - rain gage 190-Anemometer and Vane - wind velocity and direction sensor
	2050 North, Clinton	202-Float Gage - liquid level (Howard Slough) 203-Tipping Bucket - rain gage 206-Pressure Transducer - liquid level (2050 N. storm drain)

\*Funded by the Utah Geological and Mineral Survey

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Davis County computers use the QNX Version 1.25A (Quantum Software Systems, Ltd.) operating system. Enhanced ALERT Version 1.35 (Sierra-Misco, Inc.) is used to gather and store sensor readings in a data base, to set alarms for critical conditions, to provide modem communication abilities for access to and by other systems and terminals, and to allow data manipulation to generate tabular reports and data graphs.

#### Types Of Data Output Available

The Enhanced ALERT software system is capable of reporting data in the following formats: 1) list of sensors in the data base, with sensor types; 2) single sensor data

tabular reports; 3) group sensor data tabular reports; 4) plots of single sensor data versus time using character graphics; 5) bar charts with character graphics; 6) plots of two sensor's data with character graphics; 7) plots of two sensor's data in graphics mode; 8) plots of four sensor's data in graphics mode; 9) sensor maps using character graphics; and 10) sensor maps using graphics mode. Enhanced ALERT Version 1.35 is a menu-controlled software system and should not be difficult to operate for those with experience in using computer programs.

#### Instructions For Modem Access To Davis County FWIS Data

One modem and telephone line is currently available for limited public use to access the Enhanced ALERT system and obtain sensor data. Our modem is a 1200 BAUD Hayes compatible. The modem phone number is 451-3432. The system is accessible 24 hours a day seven days a week, except during power failures. Refer to your computer and modem instructions to determine how to make connection with our modem.

After the phone connection is made, a blank screen will appear, enter a carriage return. The program title will appear followed by a request to log in. Enter "User" and carriage return. A password will be requested. Enter "Weather" and carriage return. The main program menu will then appear. Follow instructions to enter into the desired subprograms. To promote availability of the modem access to

the public, the Davis County Flood Control ALERT system is programmed to limit users to five-minute blocks of time. If more extensive access to the system is desired, please contact Davis County Flood Control.

No charge is currently required to use the ALERT system. This may change depending upon telephone costs and other considerations. Please advise the Davis County Flood Control office if you will be using this service so that we can advise you of any changes. During major weather events, please keep data transmissions to a minimum so that the system is available to all.

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