

THE URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
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A POSITIVE APPROACH TO STORM DRAINAGE AND FLOOD CONTROL

By *TED DIEFFENDERFER*

*Director of Storm Drainage and Flood Control Utility
Boulder, Colorado*

On August 21, 1973 the Boulder City Council passed Ordinance number 3927, which may well be one of the most significant efforts to date to solve the drainage and flood control problem facing nearly every community in this country.

This was the result of an effort that began in the metro Denver area shortly after the devastating flood of 1965. A group of concerned city and county engineers began meeting informally. They called themselves the Five County Engineers. This group was seeking a higher level of standards in all areas of municipal construction. First, they attacked the massive problem of solving the diverse criteria then being used to approach the design and construction of storm drainage and flood control.

It quickly became apparent that a regional approach was the only reasonable solution to a natural function of our environment which did not recognize political boundaries regardless of the wishes of any given community.

It was obvious that any given storm of a 25 or 50 year magnitude which may have been adequately provided for in one governmental jurisdiction and inadequately provided for in another down stream, was going to move through the downstream community regardless, often causing devastating damage due to the disregard of providing adequate facilities by the downstream community.

Therefore the Five County Engineers appointed a Committee with the author as chairman to develop a strategy. This resulted in a three-pronged approach as follows:

- a) Develop uniform design criteria applicable to the Denver Metro area.
- b) Develop a master plan for every stream and drainage basin which would be politically acceptable to the diverse communities in the Metro Area.

- c) Develop a strategy to implement the planning at all levels of government, federal, state, county and local, both political and financial.

The first of these was accomplished by a joint effort with the Denver Regional Council of Governments, under a contract with the firm of Wright-McLaughlin Engineers. This firm, probably for the first time, pulled together a set of design criteria known as the Urban Storm Drainage Criteria Manual. This guide book contained not only technical design criteria but dealt with areas such as policy, law and planning, that up to that time had been given little consideration by most governmental agencies.

The second phase has been accomplished at least for the City of Boulder, for every stream that courses the city. There are some sixteen of these streams and watercourses, not counting Boulder Creek, which presents special problems and is receiving special treatment.

(A conceptual plan for Boulder Creek is nearing completion which uses a somewhat unique approach in that it is essentially non-structural in nature. It may well be that when this plan is refined and accepted by the community, it should be the subject of scrutiny in a separate article.)

The third phase of implementation has come about by the joint effort of such people as State Senator Joe Shoemaker, Engineers Kells Waggoner and Horace Smith, and many others in getting the State Legislature to create the Urban Drainage and Flood Control District. This agency provides a vehicle at the state level for planning, coordination, and financial assistance in implementing comprehensive plans at the local level.

Finally, the Boulder City Council has taken appropriate and far-sighted action by adopting a Flood Plain Management Ordinance, and the Ordinance mentioned at

(Continued on Page 7)



TED DIEFFENDERFER graduated from Boulder High School in 1940, then attended the University of Colorado. From 1944 to 1948 he was District Engineer, Consumers Public Power District, Bridgeport, Nebraska, and that agency's District Manager, 1948-1952. He was in business for himself from 1952 to 1958, and since then has been employed by the City of Boulder. He was Field Engineer, 1958-1961, Assistant City Engineer, 1961-1964, and City Engineer, 1964-1968. He became Director of Operations in 1968, serving in that capacity until November 1, 1973, when he became Director of Boulder's newly-established Drainage and Flood Control Utility.



Report Available on the Storm of May 6, 1973

A preliminary description of flooding of May 6, 1973 was written by Leonard Rice and presented in the June 1973 issue of *Flood Hazard News*.

A report prepared by the U.S. Geological Survey and the Urban Drainage and Flood Control District discussing and summarizing the May 6, 1973 event is now being printed and will soon be available.

There was much publicity about the rareness of the precipitation and subsequent runoff. The purpose of the report is to document the extent and effects of the storm event based on more complete data than was available at the time for the preliminary report in the June issue of *Flood Hazard News*.

The U.S. Geological Survey in cooperation with the Urban Drainage and Flood Control District was operating 27 rainfall/runoff data collection stations in the Denver Metropolitan area at the time of the May 6 event.

The rainfall and runoff data from the U.S.G.S.-operated gaging stations is summarized in the report and the actual data for 16 of those stations will be available under separate cover.

For the 16 U.S.G.S. gaging stations, the 24 hour rain-

fall depth varied from a low 1.92 inches in Boulder, Colorado to a maximum of 4.38 inches in the Sand Creek Basin in Denver.

As a comparison, the 100-year 24 hour rainfall depth at the Boulder station is estimated to be 4.8 inches and at the Sand Creek station, 3.9 inches. At the same two stations the maximum one hour rainfall depth was 0.34 inches at the Boulder station and 0.48 inches at the Sand Creek station. The approximate 2-year one hour rainfall depth is estimated to be 1.0 inches at the Boulder station and 0.9 inches at the Sand Creek station. These are but two of the 16 stations summarized, but they represent the range of precipitation experienced during the event.

The rain storm was of statistical significance based on 24 hours totals, but one hour rainfall duration depths had less than a two year frequency return interval.

Runoff data was available from 11 gaging stations operated by the State of Colorado and the U.S. Geological Survey. The stream gaging stations are located on the South Platte River and four major tributaries, including Plum Creek, Bear Creek, Cherry Creek and Clear Creek.

(Continued on Page 7)

Scenes From A "Minor" Denver Area Flood in 1973



GREENWOOD GULCH OVERFLOWS AT CHERRY HILLS COUNTRY CLUB, FROM QUINCY AVENUE



FLOODING FROM GREENWOOD GULCH SHOWING OVERFLOW ABOVE CLARKSON STREET



WEIR GULCH OVERFLOW SHOWING AN INTERSECTION LEADING INTO MISSISSIPPI AVENUE



OVERFLOW OF WEIR GULCH AT 1ST AVENUE LOOKING SOUTH, DURING FLOOD OF MAY 6, 1973

Scenes From A "Minor" Denver Area Flood in 1973



RALSTON CREEK OVERFLOW AT SIMMS STREET DURING MAY 1973 STORM.



WATER ERUPTING FROM MANHOLES ALONG RALSTON CREEK BELOW CARR STREET.



FLOODWATERS FROM RALSTON CREEK IN VICINITY OF WADSWORTH BOULEVARD.



OVERFLOWING RALSTON CREEK AS SEEN IN RALSTON CREEK PARK DURING MAY 1973 FLOOD.



SANDERSON GULCH OVERFLOW BEHIND KING SOOPERS STORE AT JEWEL AND WADSWORTH.



SOUTH PLATTE RIVER FLOODPLAIN IN ADAMS COUNTY THE DAY AFTER MAY 6TH STORM.

Topographic Mapping for Drainage Master Planning

By D. J. "JACK" GIANOLA

Civil Engineer, Urban Drainage and Flood Control District

The most important aspect in the development of a Drainage Master Plan is reliable and recent topographic mapping. The Urban Drainage and Flood Control District has the sole responsibility of providing the topographic mapping for the consulting engineer who develops the Drainage Master Plan.

Criteria Established

The District has established specified criteria for the topographic mapping to be used and the procedures to be followed in the selection of a mapping firm to provide the mapping for the District.

Normally the topographic mapping is of the scale $1'' = 100'$ with a 2' contour interval. It includes the boundaries of the 100-year flood plain, and is produced in pencil on large mylar manuscripts. But sometimes the scale requirement can be changed, depending on the length of drainageway for a particular drainage basin being master planned.

Presently, the District is using plain topographic mapping on all its projects except one. In that instance, the District is interested in determining if orthophoto mapping techniques can be used for our drainage projects. At this time, the consulting engineer has not worked with orthophoto mapping in enough detail to determine the major problems that will be encountered using orthophoto mapping.

Selecting a Mapping Firm

The procedure followed in the selection of a mapping firm is done by asking three (3) mapping firms to submit proposals in accordance with a mapping specification for the particular project. The mapping firm that submits the most favorable proposal, based on fee, is normally selected to do the mapping for the project.

Multi-Purpose Mapping

The topographic mapping serves several purposes. First of all, it shows all physical features of the drainageway being master planned. A field trip to the drainage basin will assist in confirming any unusual physical characteristics of the drainageway that might not appear on the topographic mapping. Secondly, the mapping is used to determine the hydraulic characteristics of the channel to be used in the routing of the flood waters. An important aspect is the determination of the needed cross sections of the drainageway (channel), which is the most important function of the topographic mapping. These cross sections are of vital importance for use in all the hydraulic calculations. Thirdly, the mapping is used to determine the stream profile, which in turn is used in many hydraulic calculations. Fourthly, once the approximate limits of the 100-year flood plain are determined, the topographic mapping, which shows all planimetric features, will be used to determine potential damage estimates.

Defining Flood Plain Limits

Finally, once an alternate has been selected by all concerned parties, in the development of the drainage master plan, the 100-year flood plain limits are accurately defined. Those limits are then scribed from the penciled manuscripts of the topographic mapping onto an orange painted mylar (negative) and contact printed onto 22" x 36" plan and profile sheets. The scribing process is basically tracing neatly all the lines and lettering from the topographic mapping (penciled manuscripts), to provide a photographic technique to transfer the mapping to the plan and profile sheets. Once this topographic mapping is on the plan and profile sheets, the engineer will display the proposed improvements, the required right-of-way to be acquired, and any other important information related to the drainage master plan.



EXAMPLE OF AN ORTHOPHOTO MAP

(Lena Gulch)

Courtesy Olympus Aerial Surveys, Inc.

Project

Mapper

Sanderson/Weir Gulches

Ken R. White Company
Merrick & Company

Big Dry Creek (Adams County)

Kucera & Associates

South Boulder Creek

Kucera & Associates

Little Dry Creek

Merrick & Company

Niver Creek

Merrick & Company

Goldsmith Gulch

Kucera & Associates

Lena Gulch

Olympus Aerial Surveys, Inc.

Brighton Drainage Basin

Nelson, Haley, Patterson & Quirk

First Creek

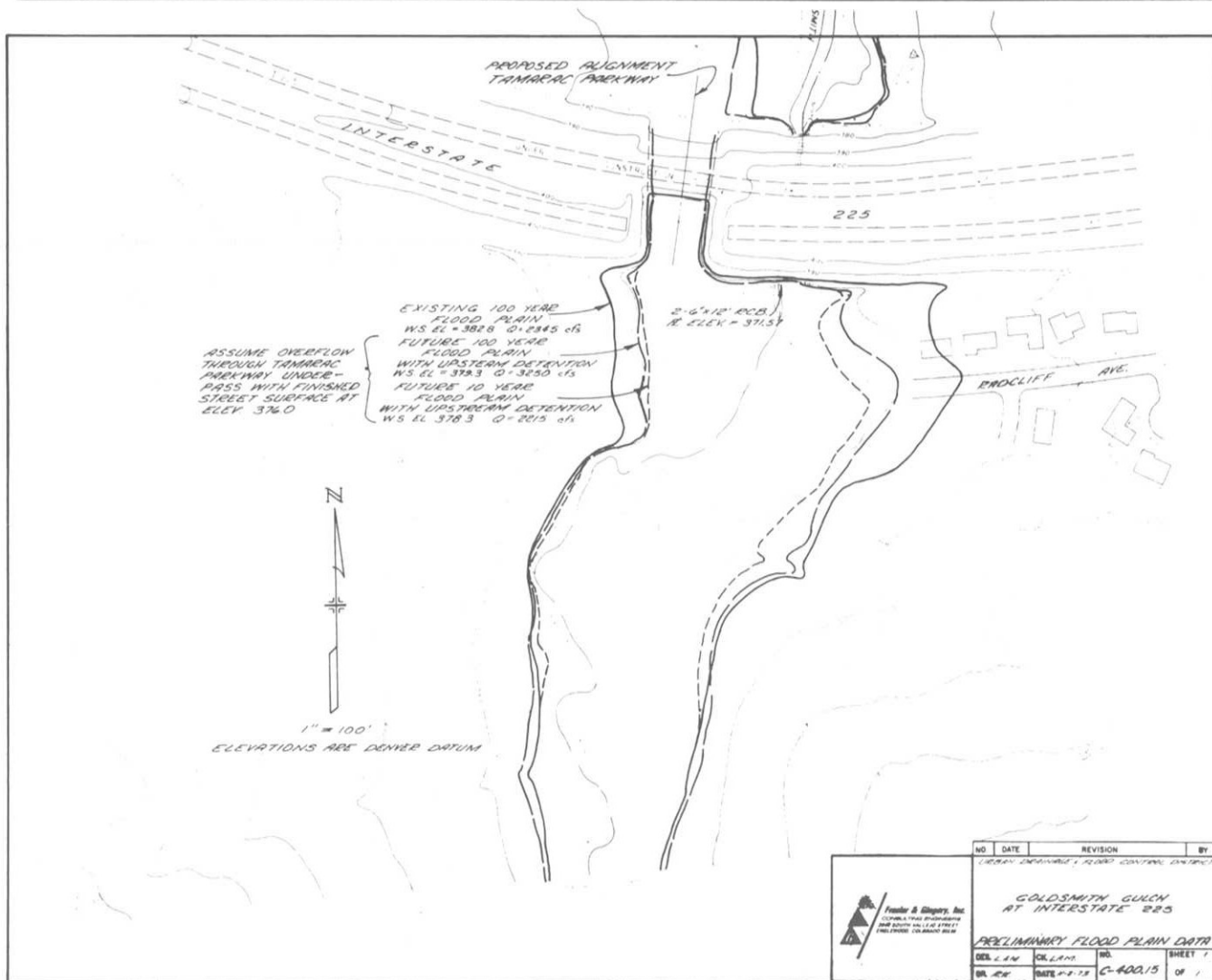
Merrick & Company

Lakewood/McIntyre Gulches

Parker Aerial Surveys

Big Dry Creek (Arapahoe County)

Bell Mapping Company



EXAMPLE OF AN ORDINARY TOPOGRAPHIC MAP
(Goldsmith Gulch)
Courtesy Kucera & Associates, Inc.

Tucker-Talk

by L. SCOTT TUCKER

Timely Comment from the District's Executive Director



SANDERSON GULCH PROJECT

A contract for the Final Design of drainage and flood control improvements on Sanderson Gulch was consummated in September, 1973. The final design for Sanderson Gulch will be performed by Frasier & Gingery, Engineering Consultants. The agreement was signed by the City of Lakewood, City of Denver, Frasier & Gingery, and the Urban Drainage and Flood Control District. Final design is scheduled for completion on June 30, 1974.

Execution of the Agreement climaxed several months of negotiations between Lakewood, Denver, the District, and the Engineer. The project is the first in the Denver area for multi-jurisdictional cooperation in drainage and flood control involving the Urban Drainage and Flood Control District.

Following completion of final design, Denver and Lakewood will prepare and let bids for construction in each of their areas and will provide on-site supervision. Both cities will be responsible for maintaining the improvements within their respective jurisdictions upon completion of the project.

ENLARGED BUDGET APPROVED

The Board of Directors, at a business meeting held immediately following a public hearing held on October 4, 1973, approved the 1974 budget which included not only operation and planning of the District but also certain capital construction projects.

The operating and planning budget is based on 1/10 of a mill property tax levied over the entire District in addition to funds contributed by local entities for planning projects. The total operating and planning budget is \$584,400.

Based on legislation passed by the 1973 State Legislature, authorizing up to 4/10 of a mill levy for construction, the Board approved a capital construction budget. The budget is based on a 0.4 mill levy levied over the entire District, plus State monies and matching funds supplied by local entities. The total capital construction budget is \$3,355,800.

The two projects approved for implementation in 1974 are improvements to Englewood Dam in Arapahoe Coun-

ty, and drainage and flood control improvements to Weir Gulch in Lakewood and Denver.

The assessed valuation of all property in the District subject to taxation is \$3,521,546,195. The new assessed valuation represents an increase of about 11½ percent over the previous assessed valuation of one year ago.

HAZARDS CONFERENCE:

I attended a conference on Natural Hazards Research at Estes Park, Colorado on October 16, 17 and 18. The University of Colorado, under the direction of Dr. Gilbert White and Dr. Eugene Haas, is conducting an assessment of research on natural hazards for the National Science Foundation. The project is intended to provide the National Science Foundation a basis for developing a comprehensive research program in the area of natural hazards.

The invitational conference was intended to provide a critical examination of tentative findings and recommendations that the research group has thus far developed. Flooding was only one of several natural hazards being examined. Other natural hazards include volcanoes, earthquakes, hurricanes, tornadoes, lightning, hail, urban snow, drought, coastal erosion, landslides, wind storms, avalanches, and frost. Land use management warning, relief and rehabilitation, and hazard insurance were also topics of evaluation at the conference.

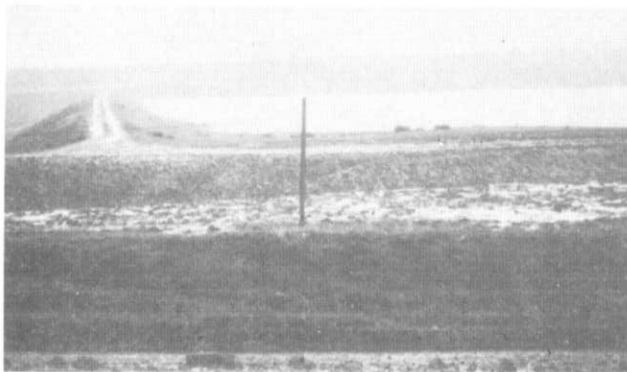
Although the conference was very serious in nature, and very productive, there were some interesting lighter moments. One was when it was noted by Ronald Stephenson, County Commissioner from Rapid City in Pennington County, South Dakota, that their devastating flood had one benefit in that it flushed out and cleaned the flood plain. Mr. Stephenson defined this phenomenon as the enema principle, which while perhaps somewhat beneficial was painful and not to be recommended. Other selected indications gleaned from the hazards conference:

In general, people are pretty ignorant.

There is a direct correlation between politics and power.

There are more votes on one side than the other.

(Continued on Page 7)



TWO VIEWS OF ENGLEWOOD DAM AND RESERVOIR, MAY 6, 1973

A Positive Approach

(Continued from Page 1)

the beginning of this paper which sets up the storm drainage flood control functions of the city as a separate utility.

On this firm foundation we have undertaken the massive job of rehabilitation of the natural drainageways within the City of Boulder, and the upgrading of our entire drainage system.

Perhaps a few words should be devoted to the actual ordinance itself. In addition to creating a separate utility, and segregating funds for drainage and flood control, the measure also provides for the collection of a service charge to generate a local level of funds collected specifically for drainage and flood control works.

These clearly identified funds enable the community to enlist financial aid from other governmental agencies such as the Urban Drainage District, State Water Conservation Board, State Legislature, and from miscellaneous sources including the sale of materials salvaged from projects.

Moving ahead on this basis, Boulder will be able to accomplish a \$22 million program over an estimated 12-year span. We consider this a positive approach to the challenging problems inherent in storm drainage and flood control.

Tucker-Talk

(Continued from Page 6)

The grass roots are at the top, not the bottom.

Unfortunately, the watch is running ahead of us.

ENGLEWOOD DAM:

The Board of Directors in May, 1973, agreed to accept the ownership of Englewood Dam if certain conditions are met. The Board came to this agreement only after it was determined that there was an absence of a desire by anyone or any combination of the local entities involved to own the dam. The major condition for accepting the dam is that improvements be made to the facility so that it will be capable of storing the 100-year flood and passing the probably maximum flood. The estimated maximum costs of these improvements is \$1,000,000.

At their October, 1973 meeting the Board committed \$400,000 of District funds to the project. In addition to the District's commitment, the State of Colorado has appropriated \$200,000 for the project, Englewood — \$300,000, and Cherry Hills Village — \$20,000. Arapahoe County is expected to approve its \$70,000 share in the near future. Greenwood Village is also being asked for \$10,000 for the project.

Englewood Dam and the property surrounding it is currently owned by SMS Ventures, Incorporated. SMS Ventures is seeking a rezoning from the Arapahoe County Commissioners in order to develop a planned unit development for the general area. The developer will transfer title to the dam and land for a spillway to the Urban Drainage and Flood Control District. The developer will also donate approximately 160 acres behind the dam for open space purposes that is required for a flood pool.

Englewood Dam is empty most of the time and is very innocent looking. In fact, most of the people living in the area have never seen water behind the dam. However, the dam has functioned effectively in several storms since it was constructed in 1936, as evidenced by about six feet of sediment that has been deposited in the bottom of the flood pool area. The dam held back a large quantity of water during the May 6, 1973 flooding, which certainly would have caused substantial damage downstream.

Report Available

(Continued from Page 2)

The recurrence intervals for the peak runoff stages on the Platte River varied from a low of 25 years upstream of Denver at Waterton to a maximum of slightly greater than 50 years downstream of Denver at Henderson, Colorado.

The recurrence interval values for the gaged tributaries varied from a low of 5 years on Cherry Creek upstream of Denver to 20 years on Bear Creek near its confluence with the Platte River.

Most of the District drainage and flood control planning and implementation projects have addressed the problems on the smaller tributaries to the Platte River. No gaging stations are operated on the smaller tributaries, and as a result, the U.S.G.S. made indirect measurements of peak flows on nine smaller Platte River tributaries. The approximate recurrence interval on the nine tributaries was lower than the recurrence intervals experienced on the four larger tributaries with gaging stations and the main stem of the South Platte River. The approximate recurrence interval varied from less than 2 years on Sanderson Gulch to 15 years on Big Dry Creek in Arapahoe County and Lena Gulch in Jefferson County.

It appears that the smaller tributaries are less effected by low intensity long duration storms than by higher intensity storms of shorter duration. On the other hand, the larger tributaries and the main stem of the South Platte River can be rather severely affected by low intensity long duration precipitation events.

It must be remembered that each storm event is a unique occurrence, and as such, will never be exactly repeated. We will never see the likes of the May 6 event again in terms of intensity, duration and extent, but we can rest assured that we will experience at some time, floods of greater magnitude.

A limited number of reports will be available upon request from the Urban Drainage and Flood Control District.

The pictures at left testify to the fact that the dam can and did contain substantial quantities of water.

WORKSHOP IN POLAND

I left Denver for Poland on November 3, to attend the "International Workshop on Hydrological Effects of Urbanization" held in Warsaw November 8, 9, and 10. The purpose of the workshop was to review a draft report on "Hydrological Effects of Urbanization: Environmental Impact" that had been prepared by the IHD/Unesco subgroup on the effects of urbanization on the hydrological environment.

A total of about 70 persons, attended the workshops with 15 coming from the United States. Travel and expenses of the participants was supported by the National Science Foundation. There will be a report in the next issue of *Flood Hazard News* on Tucker Travels along with other Tucker Talk.

5-YEAR PLANNING:

The Urban Drainage and Flood Control District is in the process of preparing 5-Year Programs for both drainage master planning and construction. Development of the 5-year programs are in initial stages. Input will be sought from local entities in the District area for development of the 5-Year programs. Following adoption by the Board of Directors of the Urban Drainage and Flood Control District, the 5-Year plans will serve as guidelines for future District efforts. It is the intention that the 5-year plans will be reviewed and revised as appropriate on an annual basis.

THE URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

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FLOOD HAZARD NEWS
Henry W. Hough, *Editor*

*"Dedicated to reducing the danger to property
and to the health and safety of persons living in the urban area"*

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