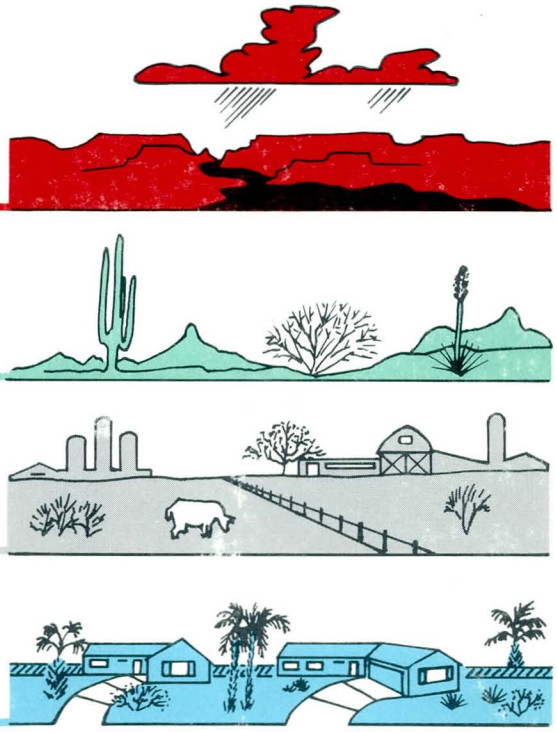

FLOOD CONTROL
DISTRICT OF
MARICOPA COUNTY

DAMBREAK ANALYSIS OF SUNNYCOVE DAM ON SUNSET WASH WICKENBURG, ARIZONA

Timothy E. Sutko

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Prepared by:

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Date: January, 1987

INTRODUCTION

This report presents the results of an analysis of downstream flooding which would result from the failure of Sunnycove Dam, an earthen flood control structure located in Wickenburg, Arizona. The analysis was performed by the Flood Control District of Maricopa County using the SMPDBK computer model developed by Dr. D. L. Fread and Jonathan N. Wetmore of the National Weather Service. The report includes a map of the inundated area to assist in emergency planning.

PURPOSE

This study was conducted in order to determine the area which would be at substantial risk of loss of life and property in the event of a failure of Sunnycove Dam. Such a determination is required by the Arizona Department of Water Resources, Office of Dam Safety, under Arizona Revised Statutes 45-701 through 45-717. The inundation map prepared as a result of this study will be used to prepare warning and evacuation maps to be maintained and implemented by the Maricopa County Civil Defense and Emergency Services Departments.

LIMITATIONS

While any number of scenarios describing the failure of Sunnycove Dam and the downstream hydraulic regime can be conceived, an exhaustive analysis of each of them is not feasible. Inasmuch as the purpose of this analysis was to provide information on the extent of flooding which would result from a dam failure so as to prevent loss of life, only a "worst case" scenario was modeled. As such, the time of failure was assumed to be relatively short (24 minutes), the size of the breach was assumed to be large (a width of 140 feet), and the reservoir was assumed to be at spillway elevation when computations commenced. The dam failure was assumed to be caused by piping.

No attempt was made to model the downstream flooding which would result from dam failure caused by overtopping of the structure. A previous investigation by the Arizona Department of Water Resources (formerly the Arizona Water Commission) used the Probable Maximum Flood hydrograph as the inflow hydrograph with the reservoir initially at spillway level. The emergency spillway passed this design hydrograph without the dam overtopping and the resulting downstream hydrograph had a peak less than that resulting from the breached dam.

The downstream limit of the modeled area was the Atchison, Topeka and Santa Fe Railroad (AT&SF RR) embankment along the western side of the Hassayampa River. Areas beyond this limit which have been projected to be inundated have been done so based upon hydrologic judgement.

DESCRIPTION OF AREA

Sunnycove Dam and basin are located on Sunnycove Wash in south-west Wickenburg, Arizona. The embankment is a zoned-earthfill structure with a maximum height of 48.5 feet above the streambed. The crest of the dam at elevation 2178.5 feet above msl is 714 feet in length. At spillway elevation, the reservoir has a capacity of 218 acre feet. The dam and impoundment area occupy approximately 18 acres of the total 1.35 mi^2 drainage area of Sunnycove Wash.

The dam was designed by the U.S. Soil Conservation Service and construction was completed in 1976. The Flood Control District of Maricopa County, the local flood control sponsor, operates and maintains the flood control features. The purpose of the structure is to provide flood protection for the mainly residential area downstream. Sunnycove Dam was designed to detain water only during times of floods.

METHODOLOGY

The response of the Sunnycove Dam impoundment, Sunnycove Dam and the area downstream of this structure was modeled using the SMPDBK computer model developed by Dr. D. L. Fread and Jonathan N. Wetmore, Office of Hydrology, National Weather Service, Silver Springs, Maryland. SMPDBK computes downstream water surface elevations resulting from the failure of an upstream dam.

The SMPDBK model retains the critical deterministic components of the numerical DAMBRK model while eliminating the need for large computer facilities and more than minimal data requirements. SMPDBK accomplishes this by approximating the downstream channel as a prism, neglecting the effects of off-channel storage, concerning itself with only the peak flows, stage, and travel times, neglecting the effects of backwater from downstream bridges and dams, and utilizing dimensionless peak-flow routing graphs developed using the DAMBRK model.

As implemented in this study, the modeling process can be envisioned as consisting of three functional steps. The first of these is the calculation of the peak outflow at the dam using the temporal and geometrical description of the breach and the reservoir. Inasmuch as this modeling effort was predictive in nature rather than an attempt to recreate an historical event, the selection of values of the parameters used to describe the breaching of the dam was somewhat arbitrary. The values of these parameters were selected so as to maximize flow from the dam while remaining within the range of values suggested by the authors of the model.

The second step in the modeling process is the approximation of the channel downstream of the dam as a prismatic channel. The SMPDBK model accomplishes

this by defining a single cross section (an average section that incorporates the geometric properties of all intervening sections via a distance weighting technique) and fitting a mathematical function that relates the section's width to depth. Top width vs depth data were obtained from topographic maps of the area.

Because a single mathematical function is used to describe all cross sections, it is possible for the model to incorrectly project the cross-sectional area at a given point, and consequently the depth of flow at all points. With this in mind, the SMPDBK model was modified by this author to display both the given and computed cross-sectional areas at the defined cross sections, along with the per cent error in the computed area. It was then possible to iteratively adjust the given top widths for a given depth so as to minimize the error in computed area at the computed depth of flow. The validity of this approach was verified through conversation with Dr. Fread.

The final functional step is the downstream routing of the breach hydrograph. This routing is achieved by employing dimensionless curves developed using the DAMBRK model.

DISCUSSION OF RESULTS

The failure of Sunnycove Dam under the conditions modeled would result in downstream flooding of a magnitude not experienced in that area before. The peak discharge at the dam (17000 cfs) would be over twice that of the Probable Maximum Flood (7700 cfs), that flood which would occur under the most severe hydrometeorological conditions possible. Figure 1 indicates the areas which would be inundated as a result of the failure of this structure.

The flood waters released through the breached dam would for the most part be confined to the area south of U.S. Highway 60. However, the area bounded by Yavapai Street, AT&SF RR, and U.S. Highway 60 is also likely to be flooded. Output from the model indicates that the depths of flow in the severe hazard area would range from in excess of 11 feet a short distance below the dam to nearly 4 feet at the downstream end of the routing reach. However, inasmuch as the SMPDBK model neglects the backwater effects caused by downstream bridges, and since the AT&SF RR embankment would in reality cause ponding to occur on its upstream side, water surface elevations approaching the top of the railroad embankment could be expected at the lower end of the study area.

Coupled with flow velocities of 9-15 feet per second, these water depths can be expected to cause structural damage to utilities and buildings in the path of the flood wave. The town of Wickenburg's maintenance yard immediately below the dam will certainly be destroyed along with any equipment located there. Considering that many of the houses in Sunset Wash below Sunnycove Dam are older frame buildings, it should be expected that they will be swept off of their foundations and demolished. Utility poles and large trees may very well

be up-rooted. The resulting wreckage will cause further endangerment to lives downstream.

Within the area likey to be inundated (as indicated in Figure 1), velocities will not be as great as indicated above, and most of the property damage will be due to standing rather than flowing water.

Due to the very short travel time for the flood wave (less than 10 minutes to the railroad embankment) and the magnitude of its peak, extensive property damage and the loss of life would be unavoidable if Sunnycove Dam were to breach without adequate warning. It is also likely that the AT&SF RR bridge over Sunset Wash and a major portion of the embankment in that area would be washed out by the passage of the flood wave.

CONCLUSIONS

This report has presented the results of an analysis of the downstream flooding which would occur following the failure of Sunnycove Dam. Loss of life would be unavoidable without adequate warning of imminent dam failure and timely evacuation of the downstream area. Devastation of property would be unavoidable in any case. The destruction of electrical, telephone, water and sewage utilities in the affected area would also be likely.

This being the case, it is recommended that the Flood Control District of Maricopa County continue its practice of monitoring the structure when water is impounded, and insure that its personnel have adequate training on the proper procedures to follow in the event of potential dam failure.

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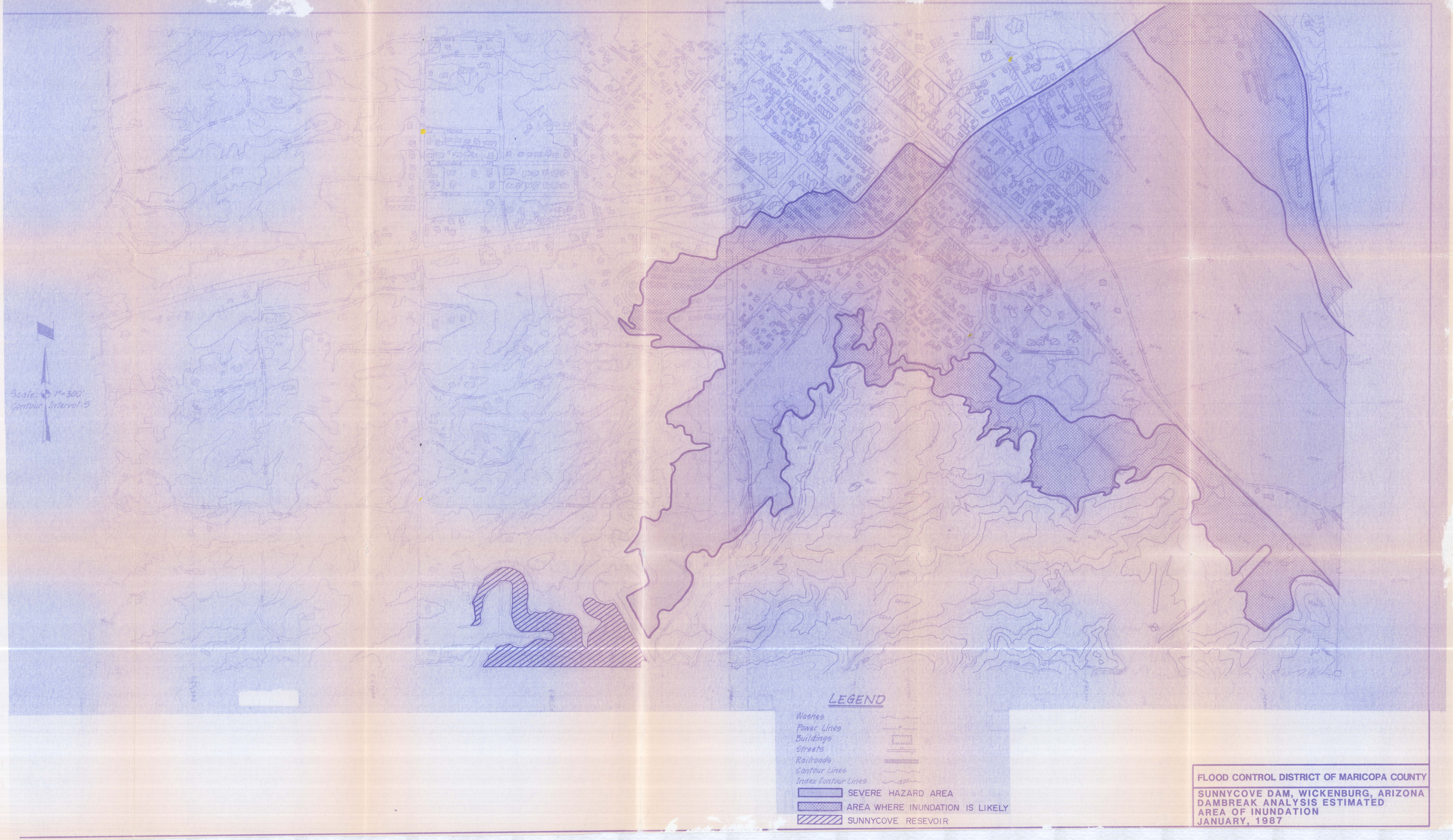

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

SUNNYCOVE DAM, WICKENBURG, ARIZONA
DAMBREAK ANALYSIS ESTIMATED
AREA OF INUNDATION
JANUARY, 1987