COACHELLA VALLEY WATER DISTRICT
GUIDELINE K - 6
FRAMEWORK FOR HYDROLOGIC MODELING

K-6.1 General Design Criteria

Coachella Valley Water District's (CVWD's) Ordinance No. 1234.2 describes the hydrologic criteria for flood control design within the stormwater service area.

K-6.2 CVWD Design Standards

Coachella Valley Water District's (CVWD's) Ordinance No. 1234.2 describes the hydrologic criteria for flood control design within the stormwater service area. The development of design storms is described below.

K-6.3 Hydrologic Modeling Guidelines

Objectives

The overall objectives of the hydrologic modeling guidelines are to:

- Provide logical and technically defensible standards that provide an appropriate level of protection for the public and CVWD facilities
- Provide consistent estimates of design flows which are as reliable as possible recognizing the limitations and uncertainty imposed by the scarcity of hydrometric data in the area
- Establish an approach to hydrologic modeling which is reasonably consistent with the current state-of-the-art, again recognizing the limitations imposed by the scarcity of hydrometric data
- Provide a consistent framework for analysis and product delivery to facilitate CVWD review and approval

Modeling Approach

Except for the very few locations in this arid region where long-term streamflow records are available, CVWD recommends rainfall-runoff modeling for hydrologic analysis. CVWD currently recommends that hydrologic modeling use HEC-HMS.

Hydrologic models shall encompass the entire area that could contribute surface runoff to points of interest for flow analysis. Sub-basins for hydrologic modeling should be delineated to take into account the gross variations in meteorological inputs and hydrologic response over the contributing areas.

Rainfall-Runoff Modeling

A synthetic unit hydrograph procedure is recommended for converting the design rainfall hyetograph to a runoff hydrograph. This requires specifying both hydrologic loss rates (hydrologic infiltration rates) and unit hydrographs for the contributing areas.

Loss Rates

Initial and constant losses should be estimated from existing maps of soils/surficial geology and land cover. CVWD recommends the use of SCS curve number methodologies to estimate loss rates for pervious areas. For areas that have not been mapped (there are no published soils maps for most of the Santa Rosa and San

Bernardino Mountains), soil hydrologic characteristics can be estimated by extrapolation from mapped areas. In general, CVWD recommends a constant loss rate of 0.1 inches/hour for mountainous areas with a thin soil cover over bedrock.

Although the Green-Ampt method is commonly used for calculating infiltration, it is not recommended for hydrologic modeling in the Coachella Valley. A CalTrans desert hydrology study (WEST 2007) compared rainfall runoff simulations for the Green and Ampt and SCS Curve Number methodologies and found that the Green-Ampt method greatly overestimated infiltration losses for the majority of test watersheds. The study recommended that CalTrans not use the Green-Ampt method for desert hydrology studies.

Unit Hydrographs

The USACE Whitewater River dimensionless S-graph is recommended to determine a basin or subbasin specific unit hydrographs. This S-graph is included with this guideline as Appendix 6A or can be obtained from USACE (1980), RCFCWCD (1978; called the "Desert S-Graph") or from CVWD. However, the Whitewater S-graph is now more than 30 years old. It may be advisable to review the basis for the S-graph and to determine whether an update using more recent information is warranted.

Meteorological Data

The 100-year design hyetograph or storm will be developed from point rainfall depths for storm durations ranging from 5 minutes to 6 hours obtained from NOAA Atlas 14. The recommended durations are 5 minutes, 15 minutes, 1 hour, 2 hours, 3 hours and 6 hours. The preferred method for calculating the average rainfall depth in a subbasin is the use of the NOAA Atlas 14 precipitation-duration-frequency grids, available for download from the NOAA Atlas 14 website.

Point rainfall depths will be adjusted by applying depth-area reduction factors (DARFs) to reflect diminished rainfall intensity as it occurs over a wider area. For watershed areas greater than or equal to 10 square miles, DARFs determined from the U.S. Army Corps of Engineers analysis of the 1939 Indio thunderstorm (USACE 1980) will be applied to point rainfall values. The Corps' depth-area curve for the 1939 storm is included with this guideline as Appendix 6B. The applicable DARF shall be determined by estimating the reduced rainfall depth for the basin area of interest from the curve and computing the ratio of that reduced depth to the point storm depth of 6.5 inches. For example, precipitation depth for a 25-square mile area is approximately 6.0 inches, resulting in a DARF of 0.92. For watershed areas less than 10 square miles, a DARF of 1.0 (i.e. no reduction) shall be used. Different watershed areas and corresponding DARFs may be appropriate if design flows are computed for multiple analysis points.

The input hyetograph for calculation of the 100-year peak flows can be constructed by nesting the 100-year amounts for durations up to 6 hours or by applying the 6-hour storm distribution from the Riverside County Hydrology Manual (RCFCWCD, 1978; Plate E5.9). It is recommended that both methods be tested and compared to determine a critical storm pattern for the study area. A 5-minute model time step is generally reasonable for either method. The nested hyetograph can be constructed using the frequency storm option in HEC-HMS using the area-reduced Atlas 14 precipitation values at each duration up to 6 hours. A peak position of 67% is the default recommendation for the frequency storm method, though the effect of peak rainfall timing on peak runoff should be assessed with a sensitivity analysis. The synthetic storm can be developed by other approaches, but we recommend discussing such methods with the CVWD.

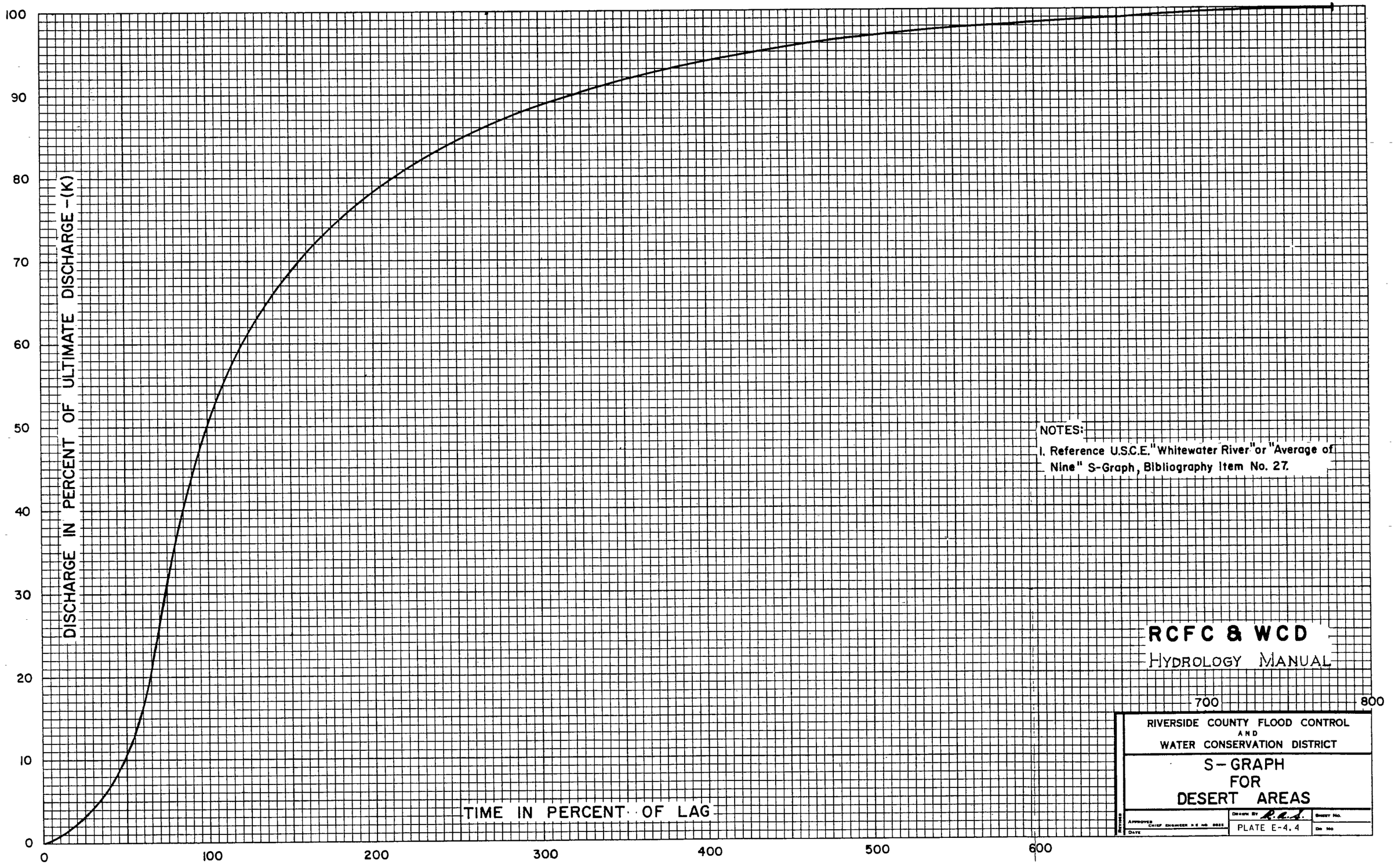
K.6.4. References

Riverside County Flood Control and Water Conservation District. 1978. Hydrology Manual. Prepared by F.J. Peairs under the supervision of J.W. Bryant and R.A. Nelson. 219 pp.

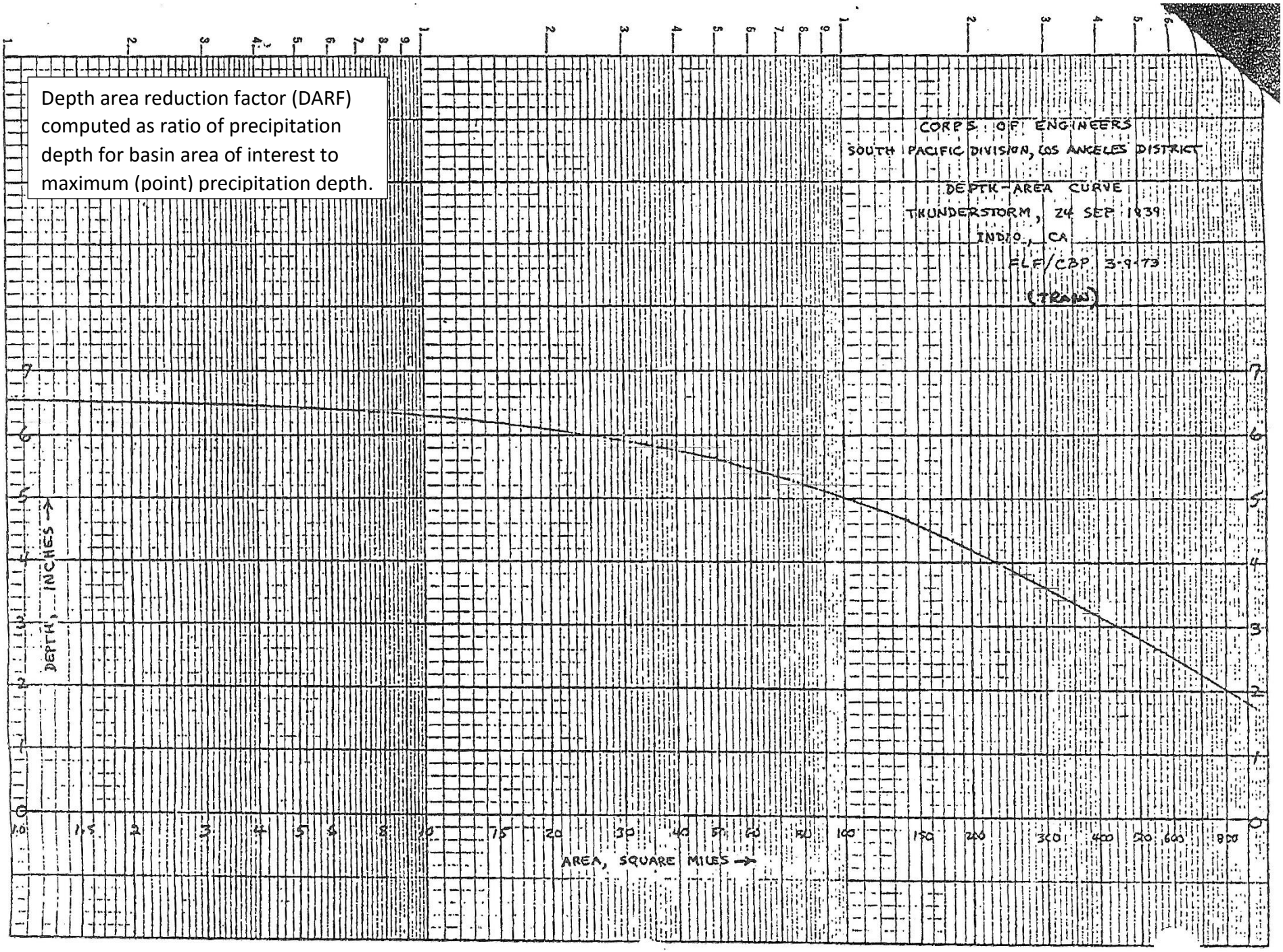
USACE. 1980. Whitewater River Basin Feasibility Report for Flood Control and allied Purposes. San Bernardino and Riverside Counties, California. Appendix 1 Hydrology. Los Angeles District.

WEST Consultants. 2007. Improved Highway Design Methods for Desert Storms. Prepared for California Department of Transportation, Report Number CA07-0592. August 2007.

Appendix K.6-A
RCFC&WCD Whitewater S-Graph


100
90
80
70
60
50
40
30
20
10
0
DISCHARGE IN PERCENT OF ULTIMATE DISCHARGE - (K)
0
100
200
300
400
500
600
700
800
TIME IN PERCENT OF LAG
NOTES:
1. Reference U.S.C.E. "Whitewater River" or "Average of Nine" S-Graph, Bibliography Item No. 27.
RCFC & WCD
HYDROLOGY MANUAL
RIVERSIDE COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
S-GRAPH FOR DESERT AREAS
PLATE E-4.4

Appendix K.6-B
USACE (1980) Depth Area Curve for 1939 Indio Thunderstorm


Depth area reduction factor (DARF) computed as ratio of precipitation depth for basin area of interest to maximum (point) precipitation depth.
CORPS OF ENGINEERS
SOUTH PACIFIC DIVISION, LOS ANGELES DISTRICT
DEPTH-AREA CURVE
THUNDERSTORM, 24 SEP 1939
INDIO, CA
FLF/CBP 3-9-73
(TRAIN)
DEPTH, INCHES →
AREA, SQUARE MILES →