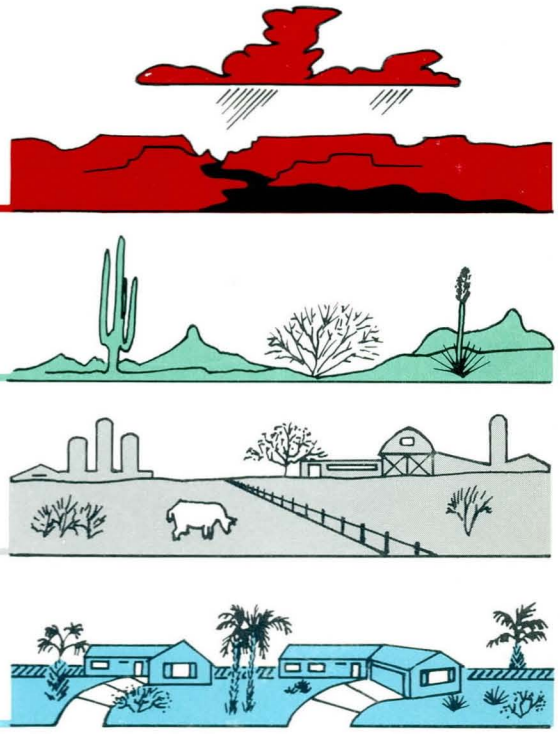

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

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Review of W. S. Gookin
and Associates Analyses
of Cudia City Wash Hydrology

April 29, 1987

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Review of W. S. Gookin
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REVIEW OF
W. S. GOOKIN & ASSOCIATES
ANALYSES OF CUDIA CITY WASH HYDROLOGY

prepared for the

Flood Control District of Maricopa County

prepared by

Timothy E. Sutko, Hydrologist
Brian C. Dietterick, Hydrologist

April 29, 1987

PROFESSIONAL

HYDROLOGIST

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EXECUTIVE SUMMARY

The engineering consulting firm of W. S. Gookin and Associates (WSG) has recently released two reports concerning the Arizona Canal Diversion Channel (ACDC), challenging the U. S. Army Corps of Engineers (COE) design analysis of that structure. The first of these reports (October, 1986) is concerned exclusively with the rainfall-runoff analysis of Cudia City Wash; the second (March, 1987) deals with rainfall-runoff analysis, design and cost estimates of Reaches 3 and 4 of ACDC. These reports were provided to the Flood Control District of Maricopa County (FCD), the local flood control sponsor of ACDC, for review and comments.

The FCD review of the October, 1986 report included the creation of a computer model of the Cudia City Wash area using the same input data as used by WSG, and also the creation of a seperate computer model of the area in order to determine the reasonableness of both the WSG and COE analyses. Numerous problems with the WSG modeling effort became evident during the review, including:

1) the use of a design rainfall depth and distribution inappropriate to the study area,

2) the apparent specification of too long a computation interval,

3) the contrasting results in hydrographs for individual subbasins and for hydrographs resulting from routing and combining flows from various subbasins,

4) apparent measurement errors of channel length, slope, and subbasin areas, and

5) suspect times of concentration.

The result of FCD's separate and independent analysis of this area indicates that the COE analysis is indeed reasonable.

The basic contention of the WSG report of March, 1987 is that the COE has over-estimated the design flows from Cudia City Wash and thereby incorrectly designed and evaluated the effects of various alternative flood control features on ACDC. The information provided by WSG in this report indicates that in fact WSG has incorrectly analyzed the design flows from Cudia City Wash, largely because of erroneous estimates of the time of concentration. Additional analyses by the FCD using a variety of methodologies further supports the COE estimates of the design flows into ACDC.

SECTION I

Analysis of W. S. Gookin & Associates
Report dated October, 1986
Cudia City Wash Runoff Analysis

prepared for the

Flood Control District of Maricopa County

prepared by

Brian C. Dietterick, Hydrologist
Timothy E. Sutko, Hydrologist

March 12, 1987

INTRODUCTION

W.S. Gookin & Associates, Consulting Engineers (WSG), on behalf of the Citizens Against Reach Four, completed a study in October, 1986 entitled Cudia City Wash Runoff Analysis. The purpose of this study was to determine the peak discharge on Cudia City Wash at the Arizona Canal resulting from a 100-year storm event and evaluate the effect of a detention basin on the outflow into the proposed Arizona Canal Diversion Channel. The Watershed Hydrology branch of the Flood Control District of Maricopa County was directed to review this report and offer comments on it. Watershed Hydrology was further directed to perform its own separate analysis to determine what it felt the peak discharge from the 100-year storm centered on the Cudia City Wash area would be. The following describes the findings of that review and analysis.

The Cudia City Wash watershed is located in the northeast section of the City of Phoenix, and is generally bounded by Camelback Mountain, Mummy Mountain, and the Phoenix Mountains. The watershed is characterized by mild to steep slopes and sparse to moderate vegetation. Historically, this area has been subject to intense thunderstorms that have caused damaging floods.

WSG MODEL

Design Storm

The storm used for the WSG analysis had a total depth of 3.80 inches and a Soil Conservation Service (SCS) Type IIA temporal distribution. The rationale given by WSG for the use of this design storm was that "this is the standard storm distribution agreed upon...for Scottsdale." The total storm depth was determined using the isohyetal maps contained in Hydrologic Design for Highway Drainage in Arizona (ADOT,1975).

The selection of a storm for use in developing the hydrology for the design of a drainage facility is to some extent arbitrary. It is common and accepted practice to use one storm for the design of an entire drainage facility, as opposed to using different storms over each of the various areas contributing runoff to that facility. The purpose of this practice is to insure continuity of the assumptions and of the design. It is therefore inappropriate, when the entire Arizona Canal Diversion Channel (ACDC) project is considered, to use a different design storm over the Cudia City Wash area than was used for the remainder of the project's contributing area.

However, inasmuch as the intent of the WSG analysis was to determine the 100-year peak discharge on Cudia City Wash at the Arizona Canal, and not to design the ACDC, a case might be made

for using a design storm and methodology other than those used by the U.S. Army Corps of Engineers (COE) in their design of ACDC. In this instance it is common practice to use, when available, the storm used by the design engineers of the municipality within whose political boundaries the drainage area lies. The purpose again is to insure continuity with other drainage facilities.

The entire Cudia City Wash drainage area is contained within the political boundaries of the City of Phoenix and the Town of Paradise Valley. The 100-year 24-hour design rainfall depth used by the engineers for these municipalities is 4.04 inches with a time distribution developed by the City of Phoenix.

The use of the Phoenix storm distribution rather than the SCS Type IIA storm would affect the timing of the peak runoff but not significantly alter its magnitude. However, the greater storm depth would increase the magnitude of the peak discharge.

FCD Model Simulating WSG Model

In order to evaluate how large this increase would be, a computer model was created using the COE Flood Hydrograph Package (HEC-1) and the WSG modeling parameters as listed in their report. These parameters include: storm depth of 3.80 inches, Type IIA storm distribution, curve numbers, lag times, and channel lengths.

Using the SCS hydrograph method, combined with the kinematic wave channel routing technique, the FCD simulated hydrographs for each subbasin. The FCD estimates of the peak discharges from each of the subbasins range from 19%-51% lower than the WSG estimates. The final routed and combined FCD hydrograph estimates the peak discharge at the Arizona Canal and matches WSG's estimate of the peak discharge to within 13%. However, at this point the FCD estimate of the peak discharge is higher than the the WSG estimate. Peak discharges for the individual subbasins and for the total basin are listed in Table 1. Appendix A contains a copy of this HEC-1 input deck and output summary.

The change from low comparative subbasin estimates to a high combined estimate suggests that differences in the routing techniques may be the cause. The FCD modeling scheme used an accepted, technically sound routing method (kinematic wave) in its HEC-1 model. The WSG model used the Lotus Spreadsheet to combine and route the subbasin hydrographs. If WSG had used the kinematic wave routing technique, their combined peak discharge would probably have been greater than the FCD estimate.

It was noted in the output from the FCD version of the WSG modeling scheme that a number of warnings were given concerning the length of the computation interval relative to the lag time used. If the computation interval is not acceptably small

Table 1. Comparison of subbasin discharges (cfs) and total basin discharges between the FCD model and the WSG model.

Subbasin	FCD model	WSG model	% Greater(WSG v FCD)
1	639	760	19
2	69	86	25
3	27	34	26
4	371	455	23
5	21	27	29
6	150	195	30
7	41	58	41
8	286	345	21
9	517	780	51
10	299	415	39
11	638	800	25
12	1238	*	
13	538	*	
14	883	*	
Total Routed Q	4835	4422	

* not calculated individually for these subbasins

compared to the lag time, there is a good possibility that peak discharges will be miscalculated. The peak discharge at the Arizona Canal from the FCD version of the WSG model, using a 6 minute computation interval, was 4835 cfs. This value rose to 5094 cfs when the computation interval was reduced to 2 minutes. These values are to be compared with a peak discharge of 4422 cfs in the WSG report. Appendix B contains a copy of the HEC-1 input deck and output summary for the computer model using a 2 minute computation interval.

Sensitivity of FCD Simulation Model to Storm Depth and Distribution

Assuming that WSG correctly modeled the Cudia City Wash area and that the FCD version was a reasonable recreation of that model, FCD then determined the effect a different design storm on the peak discharge. The City of Phoenix design storm and distribution, as described earlier, were used as input to the model. The result is a peak discharge of 5402 cfs at the Arizona Canal. Appendix C contains a copy of the HEC-1 input deck and output summary for this computer model.

WSG Report Conclusions

WSG evaluated the results of their model using estimates from a historic storm that occurred June 21-22, 1972. WSG stated that this storm "approximated a 100-year storm". However, FCD does

not believe that a recurrence interval was ever assigned to this storm. The limited data available on this storm suggests that the average storm depth over the Cudia City Wash area was approximately 3.48 inches. This storm is probably not representative of the 100-year, 24-hour, and any direct comparisons of the two are invalid.

The COE released a Report on Flood of 22 June 1972 in October, 1972. This report presents estimates of the storm depth and distribution, and of the subsequent runoff and the damages which it caused. The peak discharge from this storm at a point on Cudia City Wash 1000 feet north of McDonald Drive was estimated to have been 4200 cfs from a contributing area of 2.16 square miles in the COE report. This estimate was probably determined by the U.S. Geological Service using the slope-area method. The WSG report cites SRP as estimating the peak discharge into the Arizona Canal during that storm as being 3375 cfs from a contributing area of 5.12 square miles. SRP typically estimates storm water inflow to their canal systems by estimating the peak outflow and a change in canal storage (principle of continuity). While both of these methods are useful, the large disparity in their estimated values diminishes the use of either as a point for comparison.

INDEPENDENT FCD MODEL

The SCS Method has long been considered a reasonable means for generating storm runoff. However, this method was developed for natural catchments and its appropriateness for estimating the discharge from urban areas of this type is questionable.

Kinematic wave modeling is a physically-based, conceptual approach for generating runoff from areas where the primary flow regime is sheetflow. The input parameters are easily measured from topographic maps. Urbanized areas are particularly amenable to this type of modeling scheme.

FCD hydrology staff considered a combination of the kinematic wave and the SCS methods to be the most valid technique for generating runoff from this study area. The staff used HEC-1 to develop an independent model for this area. The kinematic wave technique was used on the urbanized subbasins having relatively less steep slopes. The SCS method was used on the two subbasins having steep slopes over a significant portion of the total area. The subbasin delineations were essentially the same as those used in the WSG analysis.

After measuring the model's physical input parameters, numerous differences between FCD estimates and the estimates WSG used in their model were noted. Differences were found in subbasin areas, channel slopes, and times of concentration. Table 2

presents FCD's and WSG's estimates of these parameters. Lag time, referred to as the time of concentration by WSG, is a function of both channel length and channel slope. The lag times used in the WSG study are therefore also suspect and are capable of changing the results significantly.

A 100-year, 24-hour storm depth of 4.04 inches with the City of Phoenix storm distribution was used. Rainfall excess was determined using SCS curve numbers. Because two overland flow planes (describing pervious and impervious surfaces) were used, two sets of curve numbers were required as input for each subbasin. The weighted average of these curve number pairs agrees with the curve numbers used by WSG.

The estimated peak discharge for the combination kinematic wave/SCS model is 6540 cfs.

Table 2. Differences between the measured physical parameters.

	Area (mi^2)		Channel length (ft)		Slope (%)	
Sub	FCD	WSG	FCD	WSG	FCD	WSG
1	0.37	0.40	6100	6706	0.043	0.147
2	0.05	0.05	1200	2376	0.050	0.143
3	0.03	0.02	1000	1056	0.050	0.076
4	0.21	0.25	3400	4330	0.059	0.138
5	0.03	0.02	800	1320	0.013	0.043
6	0.12	0.13	3200	3854	0.026	0.028
7	0.04	0.04	2000	2904	0.030	0.036
8	0.17	0.19	4200	5280	0.048	0.116
9	0.38	0.41	5200	6494	0.042	0.144
10	0.50	0.55	5800	5280	0.024	0.175
11	0.63	0.55	9800	9610	0.168	0.113
12	1.30	1.25	4800	11510	0.007	0.122
13	0.38	0.38	4600	5755	0.045	0.111
14	0.71	0.88	5400	7181	0.008	0.029

SUMMARY

Numerous problems with the WSG modeling effort became evident during our review. These include 1) the apparent specification of too long a computation interval, 2) the use of a design rainfall depth and distribution inappropriate to the study area, 3) the contrasting results in hydrographs for individual subbasins and for hydrographs resulting from combining and routing flows from various subbasins, 4) the apparent measurement errors of channel length, channel slope, and subbasin areas, and 5) the suspect times of concentration, or lag times. The WSG report indicates that the peak discharge from Cudia City Wash at the Arizona Canal resulting from a 100-year 24-hour storm event is 4422 cfs. Assuming that the WSG modeling efforts provide a reasonable description of the study area, FCD ran that same model using a shorter computation interval and the City of Phoenix design storm. This model indicates that the peak discharge is 5400 cfs at the same location. FCD then created an independent computer model of the area using what we consider to be the most appropriate methodologies and design rainfall. The peak discharge from this model at the Arizona Canal is 6540 cfs.

WSG attempts to validate their model by comparing their results to estimated discharges at the Arizona Canal resulting from the June 21-22, 1972 storm. We do not believe that direct

comparisons between the historic storm and the 100-year design storm, or between their resulting discharges, are valid.

SECTION II

Analysis of W. S. Gookin & Associates
Report dated March, 1987
Runoff Analysis, Preliminary Design and Cost Estimates of
Reaches 3 and 4 of the Arizona Canal Diversion Channel

prepared for the

Flood Control District of Maricopa County

prepared by

Timothy E. Sutko, Hydrologist

April 10, 1987

INTRODUCTION

The engineering consulting firm of W. S. Gookin and Associates (WSG) has recently completed a study of the Arizona Canal Diversion Channel (ACDC) and released its report entitled Runoff Analysis, Preliminary Design and Cost Estimates of Reaches 3 and 4 of the Arizona Canal Diversion Channel. This report was provided by the City of Phoenix to the Flood Control District of Maricopa County (FCD) for the purpose of review and comments. The FCD is the local sponsor of the ACDC. What follows are the comments of the Watershed Hydrology Branch, Hydrology Division of the Flood Control District of Maricopa County on those portions of the WSG report pertaining to hydrology.

The current report follows and to some extent expands upon the WSG report of October, 1986 entitled Cudia City Wash Runoff Analysis. While this earlier report concentrated solely upon analyzing what the peak 100-year discharge on Cudia City Wash would be, the current report presents the results of a similar analysis on all of the areas contributing runoff to Reaches 3 and 4 of ACDC (Cudia City Wash to Cave Creek). Additionally, the results of an economic analysis on these reaches are presented.

The major cause of the differences between the U. S. Army Corps of Engineers (COE) and WSG estimates of the design flows in the

ACDC is the difference in estimates of the 100-year flow into the canal from Cudia City Wash, as pointed out in the current WSG report [(13), pg 17]. Therefore, a great deal of the comments offered here will concern the Cudia City Wash area. The FCD hydrology staff has performed its own independent analysis of the 100-year flooding event on Cudia City Wash and the results of this study will be mentioned as pertinent.

Time of Concentration

The WSG report states that the COE study neglected to take into account the differing slopes of the subbasins in the contributing drainage areas. The result of this is "unrealistic times of concentration of runoff and consequently unrealistically high flood flows." [(13), Executive Summary]. This is "the primary reason for the variance in the peak flows between the studies" [(13), pg 33].

The COE procedure of determining flood hydrographs is based upon employing the results of regional analyses of historic flood events [(6,7)]. The COE uses dimensionless S-graphs derived from flood events on local watersheds with similar topographic features to produce hydrographs from the rainfall excess. These S-graphs have incorporated in them the runoff characteristics of the watersheds which are due to differing slopes. Further, the lag time (a parameter which is in essence comparable to the time of concentration used by WSG) is computed using a relationship

derived from flood events on similar watersheds. The COE estimates of the timing, magnitude and shape of the hydrographs resulting from their design storm are based upon analyses of local historic events and can certainly be considered to be reasonable.

On the other hand, WSG used a formula for computing the time of concentration, the appropriateness of which is questionable. The formula was developed in 1940 by Kirpich and was intended to be used to estimate the time of concentration for small agricultural watersheds [(5)]. It is commonly applied to determine the time of concentration for use in the Rational Method, a rainfall-runoff method which is inappropriate for the problem at hand, as recognized by WSG [(13), pg 20].

The Soil Conservation Service (SCS) recommends that different methodologies be applied to determine the time of concentration from a given area depending upon the flow regime, i.e., overland flow, shallow concentrated flow, or channel flow [(10)]. While WSG has recognized the need to consider the differing slopes within a subbasin, they have not properly accounted for them.

WSG does not mention that the differing slopes were taken into consideration in their October, 1986 study, both in their single basin analysis and in their 14 subbasin analysis [(12)]. They state in the current report that "the previous report used a wash length which began on the north side of Camelback Mountain"

[(13), pg 19]. This is in opposition to the wording of the October, 1986 report where it is stated that the time of concentration used for the one basin analysis is the weighted average of those from the 14 subbasins analysis [(12), pg 12]. It is interesting to note that the 14 subbasin analysis, which theoretically better defines the hydrologic characteristics of the area, estimates the 100-year peak discharge to be 600 cfs larger than the current report.

FCD, in its modeling efforts, has avoided the problems inherent to the computation of the times of concentration and lag times by modeling the majority of the Cudia City Wash drainage area using the kinematic wave methodology [(2)]. This is an appropriate technique for this type of subbasin, as confirmed through various Hydrologic Engineering Center (HEC) publications as well as through conversations with HEC personnel [(3,4)]. The kinematic wave technique uses various physical parameters of the subbasin (e.g., lengths, slopes, roughness, etc.,) to generate and route hydrographs. For those areas where kinematic wave was judged to be inappropriate, the SCS Unit Hydrograph method was employed. The results of the FCD model will be addressed later.

Degree of Imperviousness

The other major cause of difference in the estimated peak discharges into the ACDC is the infiltration rate, impacted primarily by the degree of impervious cover in the area. WSG states that the COE assumed a 65% impervious cover for non-mountainous regions within the study area [(13), pg 36]. This is an inaccurate statement of fact. The COE has used different estimates of the degree of imperviousness for different contributing areas, with values ranging from 20% to 80%. The higher values in this range have been applied to those areas within the Biltmore Estates where the housing is most dense. A value of 40% was used for the Cudia City Wash area [(7)]. While this value might be slightly high, it is certainly reasonable inasmuch as it takes into account bare rock, rooftops, streets, and landscaped areas underlain by "black plastic" or other similar locally employed methods of controlling weed growth. The value of 65% attributed to the COE by WSG is apparently either an unweighted average for all of the areas above the ACDC, or the COE estimate of the amount of impervious area projected for the year 2077 [(6), Plate 6].

WSG on the other hand notes that development is virtually complete in the subbasins above ACDC and east of 32nd Street. "This has impervious cover rates of 15 to 18 percent."..."Taking into account the modifying effects of the mountains with the percentage impervious areas,...a more realistic impervious cover

of 12% for subbasin 1..." (Cudia City Wash) was used by WSG [(13), pg 38]. Inasmuch as the mountains referred to are mostly bare rock, it is difficult to understand how consideration of their effect would lower the degree of imperviousness.

FCD Rainfall-runoff Analyses

As mentioned earlier, FCD performed its own analysis of the 100-year flooding event on the Cudia City Wash drainage area. The large disparities between the estimates of this event presented by COE and WSG were the impetus for this study. For this modeling effort, the Curve Numbers and subbasin delineations used by WSG [(12)] were assumed to be reasonable, the degree of imperviousness was assumed to be 35%, and the City of Phoenix design storm was used as the driving input. The kinematic wave methodology was used to generate and route the hydrographs. The result of this analysis was a peak discharge of 6540 cfs at the Arizona Canal.

In an effort to determine the quality of this modeling effort, the June, 1972 storm was used as the driving input. Estimates of the temporal distribution and average rainfall depth of this storm in the Cudia City Wash area were taken from the COE Report On Flood of 22 June, 1972, Phoenix Metropolitan Area [(9)]. The result of this validation process was a peak discharge of 2690 cfs at a point 1000 feet upstream of McDonald Drive, and 4360 cfs at the Arizona Canal. These values are to be compared

with the U. S. Geological Survey (USGS) estimate of 3000 cfs (+/- 15%) above McDonald Drive [(11)], and the COE estimate of 4000 cfs at the Arizona Canal [(8), pg A6-18]. Using this same storm in the WSG model, the predicted flow values are 1680 cfs and 3275 cfs at these same points.

It must be noted, however, that other estimates of the discharge at these points for this storm have been reported. In nearly all of their reports concerning this area, COE has erroneously reported the USGS estimate of the flow in Cudia City Wash above McDonald Drive as 4200 cfs. The source of this error is unknown. The USGS estimate of 3000 cfs above McDonald Drive was based upon slope-area measurements of the channel immediately following the flood event, and not "calculations of what they thought happened, based on the rainfall and their erroneous parameters for the basin" as reported by WSG [(13), pg 40]. Also, the Salt River Project (SRP) has estimated the peak flow into the Arizona Canal for this event as being 3375 cfs. This estimate was based upon estimates of changes in the volume of water being stored in the canal wedge at discrete points in time, as well as estimates of the discharge from the canal at various uncontrolled points.

FCD has made additional computer models of this area in order to determine the sensitivity of various parameters describing the runoff characteristics. These include the overland flow roughness coefficient, percent pervious/impervious cover, and

slope of the overland flow plane. In all cases, the peak discharge of Cudia City Wash varies from 6520-6650 cfs. Copies of the input data and output of these computer runs are contained in Appendices E-H.

FCD also created a computer model of this area using SCS methodologies, in which the entire 4.91 square miles was described as one basin. The time of concentration was estimated by measuring the length of Cudia City Wash from Mummy Mountain to its outlet at the Arizona Canal, and dividing that distance by an assumed velocity of 8 feet per second (fps). It should be noted that the slower the velocity is assumed to be, the lower the predicted discharge will be. The result was a peak discharge of 6055 cfs.

While this value appears to be low compared to other peak discharges computed by FCD, it must be kept in mind that it is only meant to serve as a check of the reasonableness of other computations, and of the impact of an erroneous assumption of flood flow velocity. In their modeling efforts, WSG used an average velocity of flow in Cudia City Wash of 4.1 fps [(13), pg 32]. As a point of comparison, the average velocity in the Arizona Canal is 3 fps. The mean slope of Cudia City Wash is nearly 10 times that of that irrigation canal, and a comparative threefold increase of the velocity is not unreasonable.

As a further check of the reasonableness of all computations, the methodology developed by the USGS for the Arizona Department of Transportation [(1)] and used for estimating the magnitude of floods on ungaged watersheds in Arizona was used. This methodology consists of regression equations in which the peak discharge for a given watershed and recurrence interval is estimated based upon drainage area size, mean elevation, and mean annual precipitation. Employment of this technique results in an estimated 100 year peak discharge of 6300 cfs.

CONCLUSIONS

The engineering consulting firm of W. S. Gookin and Associates (WSG) has released a report on their runoff analysis of the areas contributing runoff to Reaches 3 and 4 of the ACDC. The major cause of the differences between the design flows predicted by WSG and the U. S. Army Corps of Engineers (COE) can be attributed to differences in flows into the ACDC at Cudia City Wash. The primary reasons for these variances as stated by WSG are failure of the COE to account for the differing slopes in the contributing areas, and over-estimation of the degree of imperviousness on the part of the COE. In actuality, the COE methodology is one of applying regionalized S-graphs and lag time relationships which account for the differing slopes. The COE estimate of the degree of imperviousness is both reasonable and considerably less than the 65% attributed to the COE by WSG. On the other hand, the WSG estimate of imperviousness seems low.

An independent analysis by the Flood Control FCD of Maricopa County supports the COE design flows into ACDC at Cudia City Wash. The quality of the FCD modeling effort was validated by using the June, 1972 storm as the driving input and comparing the model output with measured values above McDonald Drive and at the Arizona Canal. The predicted and measured discharges at these points compare very favorably.

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13. W. S. Gookin and Associates, Runoff Analysis, Preliminary Design, and Cost Estimates of Reaches 3 and 4 of the Arizona Canal Diversion Channel, March, 1987.

APPENDIX A

FCD facsimile of Gookin model of
Cudia City Wash

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                    *DIAGRAM
*** FREE ***
          1         ID   CUDIA CITY WASH
          2         ID   RUNOFF ANALYSIS USING THE 100YR 24HR STORM
          3         IT       6  1JAN87    1200     250
          4         IO       5

          5         KK    SUB8
          6         BA    0.19
          7         IN      15
          8         PB    3.80
          9         PC     .00     .00     .01     .02     .02     .03     .04     .05     .05     .06
         10         PC     .07     .08     .08     .09     .10     .11     .13     .14     .15     .18
         11         PC     .21     .24     .42     .87    2.07    2.77    2.83    2.89    2.94    3.00
         12         PC    3.04    3.07    3.09    3.12    3.15    3.17    3.20    3.22    3.24    3.26
         13         PC    3.28    3.29    3.31    3.32    3.34    3.36    3.37    3.39    3.40    3.41
         14         PC    3.42    3.43    3.44    3.45    3.47    3.48    3.49    3.50    3.51    3.52
         15         PC    3.53    3.55    3.56    3.57    3.58    3.59    3.60    3.61    3.61    3.62
         16         PC    3.63    3.64    3.64    3.65    3.66    3.67    3.67    3.68    3.69    3.70
         17         PC    3.70    3.71    3.72    3.73    3.74    3.74    3.75    3.76    3.77    3.77
         18         PC    3.78    3.78    3.78    3.79    3.79    3.80    3.80    3.80    3.80    3.80
         19         LS       0    87.2
         20         UD    0.29

         21         KK   ROUTE
         22         RS       1    STOR       0
         23         SV       0    2.05
         24         SE       1      10
         25         SQ       0     115
         26         ST      10      95   0.611     1.5

         27         KK    R8-9
         28         RK    4700   0.016   0.030            TRAP       5       2

         29         KK    SUB7
         30         BA     .04
         31         LS       0      86
         32         UD    0.57
```

```
33      KK   ROUTE
34      RS      1    STOR      0
35      SV      0    0.78
36      SE      1      10
37      SQ      0      28

38      KK    R7-9
39      RK    2482   0.018   0.030          TRAP     5      2

40      KK    SUB9
41      BA    0.41
42      LS      0    85.4
43      UD    0.37
44      KKCB9(7&8)
45      HC      3

46      KK   ROUTE
47      RK    2500   0.008   0.030          TRAP     5      2

48      KK    SUB3
49      BA    0.02
50      LS      0      86
51      UD    0.33

52      KK   R3-12
53      RK    3696   0.016   0.030          TRAP    10      2

54      KK    SUB4
55      BA    0.25
56      LS      0    87.8
57      UD    0.32

58      KK   R4-12
59      RK    3590   0.014   0.030          TRAP    10      2

60      KK    SUB5
61      BA    0.02
62      LS      0      86
63      UD    0.52
```

```
KK   ROUTE
RS      1    STOR      0
SV      0    0.42
SE      1      10
SQ      0      14

KK   R5-12
RK   3590   0.014   0.030          TRAP     5      2

KK   SUB6
BA   0.13
LS      0      89
UD   0.56

KK   ROUTE
RS      1    STOR      0
SV      0    0.69
SE      1      10
SQ      0     156

KK   R6-12
RK   3590   0.009   0.030          TRAP    15      2
KK   SUB10
BA   0.55
LS      0    88.4
UD   1.47

KK   R10-12
RK   5016   0.008   0.030          TRAP    15      2

KK   SUB11
BA   0.55
LS      0    87.5
UD   0.51

KK   R11-12
RK   3696   0.009   0.030          TRAP    15      2
```

```
KK   SUB12
BA    1.25
LS       0    88.7
UD    0.70

KK COMBINE
HC       8

KK  R12-13
RK    2006   0.007   0.030            TRAP     20      2

KK   SUB13
BA    0.38
LS       0    88.8
UD    0.39

KK CB12&13
HC       2

KK  R13-14
RK    5597   0.009   0.030            TRAP     25      2

KK    SUB1
BA    0.40
LS       0      89
UD    0.30

KK   ROUTE
RS       1    STOR       0
SV       0    2.05
SE       1      10
SQ       0      13
ST      10      95   0.611     1.5

KK   R1-14
RK    7498   0.020   0.030            TRAP     25      2
```

```
122        KK    SUB2
123        BA    0.05
124        LS       0      86
125        UD    0.32

126        KK    ROUTE
127        RS       1    STOR       0
128        SV       0    3.28
129        SE       1      10
130        SQ       0       8

131        KK    R2-14
132        RK    7603   0.016   0.030            TRAP      25       2

133        KK    SUB14
134        BA    0.88
135        LS       0      89
136        UD    0.70

137        KKCB14&13(3,4,5,11,6,7,8,9,10 & 12)
138        HC       4
139        ZZ
```

```
****************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*            FEBRUARY 1981             *
*          REVISED 31 JAN 85           *
*                                      *
*  RUN DATE 4/29/1987   TIME 7:21:13 *
*                                      *
****************************************
```

```
****************************************
*                                      *
*    U.S. ARMY CORPS OF ENGINEERS      *
*  THE HYDROLOGIC ENGINEERING CENTER   *
*          609 SECOND STREET           *
*       DAVIS, CALIFORNIA 95616        *
* (916) 440-3285 OR (FTS) 448-3285   *
*                                      *
****************************************
```

CUDIA CITY WASH
RUNOFF ANALYSIS USING THE 100YR 24HR STORM

```
  4 IO          OUTPUT CONTROL VARIABLES
                      IPRNT          5  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE

    IT          HYDROGRAPH TIME DATA
                       NMIN          6  MINUTES IN COMPUTATION INTERVAL
                      IDATE     1JAN87  STARTING DATE
                      ITIME       1200  STARTING TIME
                         NQ        250  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE     2JAN87  ENDING DATE
                     NDTIME       1254  ENDING TIME

                 COMPUTATION INTERVAL     .10 HOURS
                      TOTAL TIME BASE   24.90 HOURS
```

```
ENGLISH UNITS
     DRAINAGE AREA          SQUARE MILES
     PRECIPITATION DEPTH    INCHES
     LENGTH, ELEVATION      FEET
     FLOW                   CUBIC FEET PER SECOND
     STORAGE VOLUME         ACRE-FEET
     SURFACE AREA           ACRES
     TEMPERATURE            DEGREES FAHRENHEIT

WARNING *** TIME INTERVAL IS GREATER THAN .29*LAG

WARNING *** TIME INTERVAL IS GREATER THAN .29*LAG

WARNING *** TIME INTERVAL IS GREATER THAN .29*LAG

WARNING *** TIME INTERVAL IS GREATER THAN .29*LAG

WARNING *** TIME INTERVAL IS GREATER THAN .29*LAG
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
				6-HOUR	24-HOUR	72-HOUR			
HYDROGRAPH AT	SUB8	286.	6.30	42.	13.	12.	.19		
ROUTED TO	ROUTE	288.	6.30	42.	13.	12.	.19	11.88	6.30
ROUTED TO	R8-9	280.	6.40	42.	13.	12.	.19		
HYDROGRAPH AT	SUB7	41.	6.60	8.	3.	2.	.04		
ROUTED TO	ROUTE	32.	6.80	8.	3.	2.	.04	11.24	6.80
ROUTED TO	R7-9	32.	6.90	8.	3.	2.	.04		
HYDROGRAPH AT	SUB9	517.	6.40	85.	26.	25.	.41		
3 COMBINED AT	CB9(7&8)	811.	6.40	134.	41.	39.	.64		
ROUTED TO	ROUTE	788.	6.40	134.	41.	39.	.64		
HYDROGRAPH AT	SUB3	27.	6.30	4.	1.	1.	.02		
ROUTED TO	R3-12	27.	6.50	4.	1.	1.	.02		
HYDROGRAPH AT	SUB4	371.	6.30	57.	17.	16.	.25		
ROUTED TO	R4-12	368.	6.40	58.	17.	17.	.25		
HYDROGRAPH AT	SUB5	21.	6.50	4.	1.	1.	.02		
ROUTED TO	ROUTE	16.	6.80	4.	1.	1.	.02		

								11.47	6.80
ROUTED TO	R5-12	16.	7.00	4.	1.	1.	.02		
HYDROGRAPH AT	SUB6	150.	6.60	31.	9.	9.	.13		
ROUTED TO	ROUTE	150.	6.60	31.	9.	9.	.13		
								9.64	6.60
ROUTED TO	R6-12	146.	6.70	31.	9.	9.	.13		
HYDROGRAPH AT	SUB10	299.	7.50	124.	38.	37.	.55		
ROUTED TO	R10-12	298.	7.60	123.	38.	36.	.55		
HYDROGRAPH AT	SUB11	638.	6.50	123.	37.	36.	.55		
ROUTED TO	R11-12	635.	6.60	123.	37.	36.	.55		
HYDROGRAPH AT	SUB12	1238.	6.70	292.	88.	84.	1.25		
8 COMBINED AT	COMBINE	3080.	6.60	768.	232.	224.	3.41		
ROUTED TO	R12-13	3068.	6.60	767.	232.	223.	3.41		
HYDROGRAPH AT	SUB13	538.	6.40	90.	27.	26.	.38		
2 COMBINED AT	CB12&13	3490.	6.60	855.	259.	249.	3.79		
ROUTED TO	R13-14	3476.	6.60	852.	258.	249.	3.79		
HYDROGRAPH AT	SUB1	639.	6.30	95.	28.	27.	.40		
ROUTED TO	ROUTE	639.	6.30	92.	28.	27.	.40		
								14.84	6.30
ROUTED TO	R1-14	618.	6.40	91.	28.	27.	.40		
HYDROGRAPH AT	SUB2	69.	6.30	11.	3.	3.	.05		

ROUTED TO	ROUTE	9.	7.20	7.	3.	3.	.05	10.68	7.20
ROUTED TO	R2-14	8.	8.10	7.	3.	3.	.05		
HYDROGRAPH AT	SUB14	883.	6.70	208.	62.	60.	.88		
4 COMBINED AT	CB14&13(	4835.	6.60	1155.	351.	338.	5.12		

APPENDIX B

FCD facsimile of Gookin model of
Cudia City Wash
Computation interval = 2 minutes

```
                    *DIAGRAM
*** FREE ***
          1         ID   CUDIA CITY WASH
          2         ID   RUNOFF ANALYSIS USING THE 100YR 24HR STORM
          3         IT       2  1JAN87    1200     800
          4         IO       5

          5         KK    SUB8
          6         BA    0.19
          7         IN      15
          8         PB    3.80
          9         PC     .00     .00     .01     .02     .02     .03     .04     .05     .05     .06
         10         PC     .07     .08     .08     .09     .10     .11     .13     .14     .15     .18
         11         PC     .21     .24     .42     .87    2.07    2.77    2.83    2.89    2.94    3.00
         12         PC    3.04    3.07    3.09    3.12    3.15    3.17    3.20    3.22    3.24    3.26
         13         PC    3.28    3.29    3.31    3.32    3.34    3.36    3.37    3.39    3.40    3.41
         14         PC    3.42    3.43    3.44    3.45    3.47    3.48    3.49    3.50    3.51    3.52
         15         PC    3.53    3.55    3.56    3.57    3.58    3.59    3.60    3.61    3.61    3.62
         16         PC    3.63    3.64    3.64    3.65    3.66    3.67    3.67    3.68    3.69    3.70
         17         PC    3.70    3.71    3.72    3.73    3.74    3.74    3.75    3.76    3.77    3.77
         18         PC    3.78    3.78    3.78    3.79    3.79    3.80    3.80    3.80    3.80    3.80
         19         LS       0    87.2
         20         UD    0.29

         21         KK   ROUTE
         22         RS       1    STOR       0
         23         SV       0    2.05
         24         SE       1      10
         25         SQ       0     115
         26         ST      10      95   0.611     1.5

         27         KK    R8-9
         28         RK    4700   0.016   0.030            TRAP       5       2

         29         KK    SUB7
         30         BA     .04
         31         LS       0      86
         32         UD    0.57
```

```
33      KK   ROUTE
34      RS      1    STOR       0
35      SV      0    0.78
36      SE      1      10
37      SQ      0      28

38      KK   R7-9
39      RK   2482   0.018   0.030          TRAP      5       2

40      KK   SUB9
41      BA   0.41
42      LS      0    85.4
43      UD   0.37
44      KK   CB9(7&8)
45      HC      3

46      KK   ROUTE
47      RK   2500   0.008   0.030          TRAP      5       2

48      KK   SUB3
49      BA   0.02
50      LS      0      86
51      UD   0.33

52      KK   R3-12
53      RK   3696   0.016   0.030          TRAP     10       2

54      KK   SUB4
55      BA   0.25
56      LS      0    87.8
57      UD   0.32

58      KK   R4-12
59      RK   3590   0.014   0.030          TRAP     10       2

60      KK   SUB5
61      BA   0.02
62      LS      0      86
63      UD   0.52
```

```
KK   ROUTE
RS      1    STOR       0
SV      0    0.42
SE      1      10
SQ      0      14

KK   R5-12
RK   3590   0.014   0.030          TRAP      5       2

KK    SUB6
BA   0.13
LS      0      89
UD   0.56

KK   ROUTE
RS      1    STOR       0
SV      0    0.69
SE      1      10
SQ      0     156

KK   R6-12
RK   3590   0.009   0.030          TRAP     15       2
KK   SUB10
BA   0.55
LS      0    88.4
UD   1.47

KK  R10-12
RK   5016   0.008   0.030          TRAP     15       2

KK   SUB11
BA   0.55
LS      0    87.5
UD   0.51

KK  R11-12
RK   3696   0.009   0.030          TRAP     15       2
```

```
KK   SUB12
BA    1.25
LS       0    88.7
UD    0.70

KK COMBINE
HC       8

KK  R12-13
RK    2006   0.007   0.030            TRAP      20       2

KK   SUB13
BA    0.38
LS       0    88.8
UD    0.39

KK CB12&13
HC       2

KK  R13-14
RK    5597   0.009   0.030            TRAP      25       2

KK    SUB1
BA    0.40
LS       0      89
UD    0.30

KK   ROUTE
RS       1    STOR       0
SV       0    2.05
SE       1      10
SQ       0      13
ST      10      95   0.611     1.5
KK   R1-14
RK    7498   0.020   0.030            TRAP      25       2
```

```
KK    SUB2
BA    0.05
LS       0      86
UD    0.32

KK    ROUTE
RS       1    STOR       0
SV       0    3.28
SE       1      10
SQ       0       8

KK    R2-14
RK    7603   0.016   0.030            TRAP      25       2

KK    SUB14
BA    0.88
LS       0      89
UD    0.70

KKCB14&13(3,4,5,11,6,7,8,9,10 & 12)
HC       4
ZZ
```

```
*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*             FEBRUARY 1981             *
*           REVISED 31 JAN 85           *
*                                       *
*  RUN DATE 4/29/1987   TIME 7:28:22 *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*    U.S. ARMY CORPS OF ENGINEERS       *
*  THE HYDROLOGIC ENGINEERING CENTER    *
*          609 SECOND STREET            *
*       DAVIS, CALIFORNIA 95616         *
*  (916) 440-3285 OR (FTS) 448-3285   *
*                                       *
*****************************************
```

```
                    CUDIA CITY WASH
                    RUNOFF ANALYSIS USING THE 100YR 24HR STORM

  4 IO        OUTPUT CONTROL VARIABLES
                    IPRNT          5  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

    IT        HYDROGRAPH TIME DATA
                     NMIN          2  MINUTES IN COMPUTATION INTERVAL
                    IDATE     1JAN87  STARTING DATE
                    ITIME       1200  STARTING TIME
                       NQ        800  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE     2JAN87  ENDING DATE
                   NDTIME       1438  ENDING TIME

              COMPUTATION INTERVAL     .03 HOURS
                   TOTAL TIME BASE   26.63 HOURS
```

ENGLISH UNITS

DRAINAGE AREA	SQUARE MILES
PRECIPITATION DEPTH	INCHES
LENGTH, ELEVATION	FEET
FLOW	CUBIC FEET PER SECOND
STORAGE VOLUME	ACRE-FEET
SURFACE AREA	ACRES
TEMPERATURE	DEGREES FAHRENHEIT

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	SUB8	300.	6.30	42.	13.	11.	.19		
ROUTED TO	ROUTE	299.	6.30	42.	13.	11.	.19		
								11.96	6.30
ROUTED TO	R8-9	293.	6.40	42.	13.	11.	.19		
HYDROGRAPH AT	SUB7	42.	6.57	8.	3.	2.	.04		
ROUTED TO	ROUTE	33.	6.83	8.	3.	2.	.04		
								11.63	6.83
ROUTED TO	R7-9	33.	6.90	8.	3.	2.	.04		
HYDROGRAPH AT	SUB9	545.	6.37	85.	26.	23.	.41		
3 COMBINED AT	CB9(7&8)	850.	6.40	135.	41.	37.	.64		
ROUTED TO	ROUTE	846.	6.43	135.	41.	37.	.64		
HYDROGRAPH AT	SUB3	29.	6.33	4.	1.	1.	.02		
ROUTED TO	R3-12	28.	6.47	4.	1.	1.	.02		
HYDROGRAPH AT	SUB4	390.	6.33	57.	17.	15.	.25		
ROUTED TO	R4-12	389.	6.37	57.	17.	15.	.25		
HYDROGRAPH AT	SUB5	23.	6.53	4.	1.	1.	.02		
ROUTED TO	ROUTE	17.	6.80	4.	1.	1.	.02		
								11.82	6.80
ROUTED TO	R5-12	17.	6.97	4.	1.	1.	.02		

HYDROGRAPH AT	SUB6	158.	6.57	31.	9.	8.	.13		
ROUTED TO	ROUTE	156.	6.60	31.	9.	8.	.13		
								10.02	6.60
ROUTED TO	R6-12	156.	6.70	31.	9.	8.	.13		
HYDROGRAPH AT	SUB10	309.	7.50	124.	38.	34.	.55		
ROUTED TO	R10-12	308.	7.60	124.	38.	34.	.55		
HYDROGRAPH AT	SUB11	668.	6.50	123.	37.	33.	.55		
ROUTED TO	R11-12	667.	6.57	123.	37.	33.	.55		
HYDROGRAPH AT	SUB12	1285.	6.70	292.	88.	79.	1.25		
8 COMBINED AT	COMBINE	3197.	6.57	768.	232.	209.	3.41		
ROUTED TO	R12-13	3197.	6.57	768.	232.	209.	3.41		
HYDROGRAPH AT	SUB13	565.	6.40	90.	27.	24.	.38		
2 COMBINED AT	CB12&13	3669.	6.53	856.	259.	233.	3.79		
ROUTED TO	R13-14	3664.	6.60	853.	259.	233.	3.79		
HYDROGRAPH AT	SUB1	669.	6.30	95.	28.	26.	.40		
ROUTED TO	ROUTE	668.	6.30	92.	28.	25.	.40		
								15.00	6.30
ROUTED TO	R1-14	641.	6.43	91.	28.	25.	.40		
HYDROGRAPH AT	SUB2	73.	6.33	11.	3.	3.	.05		
ROUTED TO	ROUTE	9.	7.17	7.	3.	3.	.05		
								10.73	7.17

ROUTED TO	R2-14	9.	8.00	7.	3.	3.	.05
HYDROGRAPH AT	SUB14	916.	6.70	208.	62.	56.	.88
4 COMBINED AT	CB14&13	5094.	6.57	1156.	352.	317.	5.12

APPENDIX C

FCD facsimile of Gookin model of
Cudia City Wash
Using City of Phoenix design rainfall event

*** FREE ***

```
 1    ID   CUDIA CITY WASH
 2    ID   RUNOFF ANALYSIS USING THE 100YR 24HR STORM
 3    IT       6  1JAN87    1200     250
 4    IO       5

 5    KK    SUB8
 6    BA    0.19
 7    IN      30
 8    PB    4.04
 9    PC     .00     .02     .03     .05     .07     .09     .11     .13     .14     .16
10    PC     .18     .19     .21     .23     .25     .27     .29     .30     .32     .38
11    PC     .43     .48     .57     .69    2.02    3.35    3.47    3.56    3.61    3.66
12    PC    3.72    3.73    3.75    3.77    3.79    3.81    3.83    3.84    3.86    3.88
13    PC    3.89    3.91    3.93    3.95    3.97    3.99    4.00    4.02    4.04    4.04
14    LS       0    87.2
15    UD    0.29

16    KK   ROUTE
17    RS       1    STOR       0
18    SV       0    2.05
19    SE       1      10
20    SQ       0     115
21    ST      10      95   0.611     1.5

22    KK    R8-9
23    RK    4700   0.016   0.030            TRAP       5       2

24    KK    SUB7
25    BA     .04
26    LS       0      86
27    UD    0.57

28    KK   ROUTE
29    RS       1    STOR       0
30    SV       0    0.78
31    SE       1      10
32    SQ       0      28
```

```
33      KK    R7-9
34      RK    2482   0.018   0.030        TRAP    5     2

35      KK    SUB9
36      BA    0.41
37      LS       0    85.4
38      UD    0.37

39      KKCB9(7&8)
40      HC       3
41      KK    ROUTE
42      RK    2500   0.008   0.030        TRAP    5     2

43      KK    SUB3
44      BA    0.02
45      LS       0     86
46      UD    0.33

47      KK    R3-12
48      RK    3696   0.016   0.030        TRAP   10     2

49      KK    SUB4
50      BA    0.25
51      LS       0    87.8
52      UD    0.32

53      KK    R4-12
54      RK    3590   0.014   0.030        TRAP   10     2

55      KK    SUB5
56      BA    0.02
57      LS       0     86
58      UD    0.52

59      KK    ROUTE
60      RS       1    STOR       0
61      SV       0    0.42
62      SE       1      10
63      SQ       0      14
```

```
KK    R5-12
RK     3590   0.014   0.030          TRAP     5      2

KK    SUB6
BA     0.13
LS        0      89
UD     0.56

KK    ROUTE
RS        1    STOR       0
SV        0    0.69
SE        1      10
SQ        0     156

KK    R6-12
RK     3590   0.009   0.030          TRAP    15      2

KK    SUB10
BA     0.55
LS        0    88.4
UD     1.47
KK   R10-12
RK     5016   0.008   0.030          TRAP    15      2

KK    SUB11
BA     0.55
LS        0    87.5
UD     0.51

KK   R11-12
RK     3696   0.009   0.030          TRAP    15      2

KK    SUB12
BA     1.25
LS        0    88.7
UD     0.70

KK COMBINE
HC        8
```

```
KK  R12-13
RK    2006   0.007   0.030          TRAP     20      2

KK   SUB13
BA    0.38
LS       0    88.8
UD    0.39

KK CB12&13
HC       2

KK  R13-14
RK    5597   0.009   0.030          TRAP     25      2

KK    SUB1
BA    0.40
LS       0      89
UD    0.30

KK   ROUTE
RS       1    STOR       0
SV       0    2.05
SE       1      10
SQ       0      13
ST      10      95   0.611     1.5

KK   R1-14
RK    7498   0.020   0.030          TRAP     25      2

KK    SUB2
BA    0.05
LS       0      86
UD    0.32

KK   ROUTE
RS       1    STOR       0
SV       0    3.28
SE       1      10
SQ       0       8
```

```
KK   R2-14
RK    7603   0.016   0.030          TRAP     25      2

KK   SUB14
BA    0.88
LS       0      89
UD    0.70

KKCB14&13(3,4,5,11,6,7,8,9,10 & 12)
HC       4
ZZ
```

```
****************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*            FEBRUARY 1981             *
*          REVISED 31 JAN 85           *
*                                      *
* RUN DATE 4/29/1987   TIME 7:45:37 *
*                                      *
****************************************
```

```
****************************************
*                                      *
*    U.S. ARMY CORPS OF ENGINEERS      *
*  THE HYDROLOGIC ENGINEERING CENTER   *
*          609 SECOND STREET           *
*       DAVIS, CALIFORNIA 95616        *
* (916) 440-3285 OR (FTS) 448-3285  *
*                                      *
****************************************
```

CUDIA CITY WASH
RUNOFF ANALYSIS USING THE 100YR 24HR STORM

```
 4 IO        OUTPUT CONTROL VARIABLES
                 IPRNT          5  PRINT CONTROL
                 IPLOT          0  PLOT CONTROL
                 QSCAL         0.  HYDROGRAPH PLOT SCALE

  IT         HYDROGRAPH TIME DATA
                  NMIN          6  MINUTES IN COMPUTATION INTERVAL
                 IDATE     1JAN87  STARTING DATE
                 ITIME       1200  STARTING TIME
                    NQ        250  NUMBER OF HYDROGRAPH ORDINATES
                NDDATE     2JAN87  ENDING DATE
                NDTIME       1254  ENDING TIME

            COMPUTATION INTERVAL     .10 HOURS
                 TOTAL TIME BASE   24.90 HOURS
```

```
ENGLISH UNITS
     DRAINAGE AREA          SQUARE MILES
     PRECIPITATION DEPTH    INCHES
     LENGTH, ELEVATION      FEET
     FLOW                   CUBIC FEET PER SECOND
     STORAGE VOLUME         ACRE-FEET
     SURFACE AREA           ACRES
     TEMPERATURE            DEGREES FAHRENHEIT

WARNING *** TIME INTERVAL IS GREATER THAN .29*LAG

WARNING *** TIME INTERVAL IS GREATER THAN .29*LAG

WARNING *** TIME INTERVAL IS GREATER THAN .29*LAG

WARNING *** TIME INTERVAL IS GREATER THAN .29*LAG

WARNING *** TIME INTERVAL IS GREATER THAN .29*LAG
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	SUB8	260.	12.50	49.	14.	13.	.19		
ROUTED TO	ROUTE	260.	12.60	49.	14.	13.	.19		
								11.66	12.60
ROUTED TO	R8-9	258.	12.60	49.	14.	13.	.19		
HYDROGRAPH AT	SUB7	43.	12.80	10.	3.	3.	.04		
ROUTED TO	ROUTE	37.	13.00	10.	3.	3.	.04		
								12.89	13.00
ROUTED TO	R7-9	37.	13.10	10.	3.	3.	.04		
HYDROGRAPH AT	SUB9	510.	12.60	100.	28.	27.	.41		
3 COMBINED AT	CB9(7&8)	792.	12.60	160.	44.	43.	.64		
ROUTED TO	ROUTE	783.	12.70	160.	44.	43.	.64		
HYDROGRAPH AT	SUB3	26.	12.60	5.	1.	1.	.02		
ROUTED TO	R3-12	26.	12.80	5.	1.	1.	.02		
HYDROGRAPH AT	SUB4	341.	12.60	66.	18.	18.	.25		
ROUTED TO	R4-12	339.	12.60	67.	19.	18.	.25		
HYDROGRAPH AT	SUB5	23.	12.70	5.	1.	1.	.02		
ROUTED TO	ROUTE	19.	13.00	5.	1.	1.	.02		
								13.03	13.00
ROUTED TO	R5-12	19.	13.10	5.	1.	1.	.02		

HYDROGRAPH AT	SUB6	156.	12.70	36.	10.	10.	.13		
ROUTED TO	ROUTE	155.	12.80	36.	10.	10.	.13		
								9.94	12.80
ROUTED TO	R6-12	153.	12.90	36.	10.	10.	.13		
HYDROGRAPH AT	SUB10	361.	13.60	147.	41.	39.	.55		
ROUTED TO	R10-12	360.	13.70	147.	41.	39.	.55		
HYDROGRAPH AT	SUB11	657.	12.70	145.	40.	39.	.55		
ROUTED TO	R11-12	654.	12.80	145.	40.	39.	.55		
HYDROGRAPH AT	SUB12	1341.	12.80	342.	95.	92.	1.25		
8 COMBINED AT	COMBINE	3388.	12.80	905.	252.	242.	3.41		
ROUTED TO	R12-13	3381.	12.80	905.	251.	242.	3.41		
HYDROGRAPH AT	SUB13	511.	12.60	104.	29.	28.	.38		
2 COMBINED AT	CB12&13	3819.	12.80	1009.	280.	270.	3.79		
ROUTED TO	R13-14	3813.	12.80	1008.	279.	269.	3.79		
HYDROGRAPH AT	SUB1	568.	12.50	111.	31.	30.	.40		
ROUTED TO	ROUTE	568.	12.60	109.	30.	29.	.40		
								14.47	12.60
ROUTED TO	R1-14	560.	12.60	108.	30.	29.	.40		
HYDROGRAPH AT	SUB2	65.	12.60	13.	3.	3.	.05		
ROUTED TO	ROUTE	11.	13.30	8.	3.	3.	.05		
								13.42	13.30

ROUTED TO	R2-14	11.	14.00	8.	3.	3.	.05
HYDROGRAPH AT	SUB14	953.	12.80	243.	68.	65.	.88
4 COMBINED AT	CB14&13	5271.	12.80	1365.	380.	366.	5.12

APPENDIX D

FCD Kinematic wave model of
Cudia City Wash

*** FREE ***

```
 1   ID   CUDIA CITY WASH
 2   ID   RUNOFF ANALYSIS USING THE 100YR 24HR STORM
 3   IT       2 11MAR87    1200     800
 4   IO       5

 5   KK    SUB8
 6   BA   0.169
 7   IN      30
 8   PB    4.04
 9   PC     .00     .02     .03     .05     .07     .09     .11     .13     .14     .16
10   PC     .18     .19     .21     .23     .25     .27     .29     .30     .32     .38
11   PC     .43     .48     .57     .69    2.02    3.35    3.47    3.56    3.61    3.66
12   PC    3.72    3.73    3.75    3.77    3.79    3.81    3.83    3.84    3.86    3.88
13   PC    3.89    3.91    3.93    3.95    3.97    3.99    4.00    4.02    4.04    4.04
14   LS       0      98               0      81       0
15   UK      75    .005    .050      35
16   UK     200    .005     .10      65
17   RK     300     .05    .020     .06    TRAP       5       2
18   RK    4200     .05    .035            TRAP      15       2      NO

19   KK   ROUTE
20   RS       1    STOR       0
21   SV       0    2.05
22   SE       1      10
23   SQ       0     115
24   ST      10      95   0.611     1.5

25   KK    R8-9
26   RK    4699   0.016   0.030            TRAP      15       2

27   KK    SUB7
28   BA    .043
29   LS       0      98               0      80       0
30   UK      75    .005    .050      35
31   UK     200    .005      .1      65
32   RK     400     .04    .020    .013    TRAP       5       2
33   RK    2000     .03    .035            TRAP      15       2      NO
```

```
34        KK   ROUTE
35        RS       1    STOR       0
36        SV       0    0.78
37        SE       1      10
38        SQ       0      28

39        KK    R7-9
40        RK    2482   0.018   0.030            TRAP      5       2

41        KK    SUB9
42        BA   0.384
43        LS       0      79
44        UK     200    .005     .10     100
45        RK     400     .04    .020     .14    TRAP      5       2
46        RK    5200     .04    .035            TRAP     15       2      NO


47        KK CB7&8&9
48        HC       3

49        KK   ROUTE
50        RK    2500   0.008   0.030            TRAP      5       2

51        KK    SUB3
52        BA   0.025
53        LS       0      98               0      80
54        UK      75    .005    .050      35
55        UK     100    .005      .1      65
56        RK     200     .08    .020    .006    TRAP      5       2
57        RK    1000     .05    .035            TRAP     15       2      NO

58        KK   R3-12
59        RK    3696   0.016   0.030            TRAP     10       2
```

```
60      KK   SUB4
61      BA   0.213
62      LS      0     98            0     82      0
63      UK     75   .005   .050    35
64      UK    200   .005    .10    65
65      RK   2300    .05   .020   .08   TRAP      5      2
66      RK   3400    .06   .035         TRAP     15      2     NO

67      KK   R4-12
68      RK   3590  0.014  0.030         TRAP     10      2

69      KK   SUB5
70      BA   0.028
71      LS      0     98            0     80
72      UK     75   .005   .050    35
73      UK    100   .005    .10    65
74      RK    200    .04   .020  .006   TRAP      5      2
75      RK    800   .013   .035         TRAP     15      2     NO

76      KK   ROUTE
77      RS      1   STOR       0
78      SV      0   0.42
79      SE      1     10
80      SQ      0     14

81      KK   R5-12
82      RK   3590  0.014  0.030         TRAP      5      2

83      KK   SUB6
84      BA   0.123
85      LS      0     98            0     84
86      UK     75   .005   .050    35
87      UK    200   .005    .10    65
88      RK    400    .05   .020   .04   TRAP      5      2
89      RK   3200   .026   .035         TRAP     15      2     NO
```

```
90      KK   ROUTE
91      RS       1    STOR       0
92      SV       0    0.69
93      SE       1      10
94      SQ       0     156

95      KK   R6-12
96      RK    3590   0.009   0.030            TRAP     15      2

97      KK   SUB10
98      BA   0.495
99      LS       0      98              0      83      0
100     UK      75    .005    .050     35
101     UK     200    .005     .10     65
102     RK    2800    .050     .02    .18    TRAP      5      2
103     RK    5800    .024    .035            TRAP     15      2     NO

104     KK  R10-12
105     RK    5016   0.008   0.030            TRAP     15      2

106     KK   SUB11
107     BA   0.625
108     LS       0    87.5
109     UD   0.212

110     KK  R11-12
111     RK    3696   0.009   0.030            TRAP     15      2

112     KK   SUB12
113     BA    1.30
114     LS       0      98              0      84      0
115     UK      75    .005    .050     35
116     UK     200    .005     .10     65
117     RK    2725    .035    .020    .41    TRAP     10      2
118     RK    4800    .007    .035            TRAP     25      2     NO

119     KK COMBINE
120     HC       8
```

```
121     KK  R12-13
122     RK    2006   0.007   0.030          TRAP    20     2

123     KK   SUB13
124     BA   0.378
125     LS       0     98            0      82     0
126     UK      75   .005    .050   35
127     UK     200   .005     .10   65
128     RK    4300   .106    .020   .13    TRAP    10     2
129     RK    4600   .045    .035          TRAP    35     2     NO
130     KK CB12&13
131     HC       2

132     KK  R13-14
133     RK    5597   0.009   0.030          TRAP    25     2

134     KK    SUB1
135     BA    0.37
136     LS       0     89
137     UD    0.47

138     KK   ROUTE
139     RS       1   STOR       0
140     SV       0   2.05
141     SE       1     10
142     SQ       0     13
143     ST      10     95   0.611    1.5

144     KK   R1-14
145     RK    7498   0.020   0.030          TRAP    25     2

146     KK    SUB2
147     BA   0.054
148     LS       0     98            0      80
149     UK      75   .005    .050   35
150     UK     200   .005     .10   65
151     RK     300     .1     .02   .02    TRAP     5     2
152     RK    1200    .05    .035          TRAP    10     2     NO
```

```
153     KK   ROUTE
154     RS      1    STOR       0
155     SV      0    3.28
156     SE      1      10
157     SQ      0       8

158     KK   R2-14
159     RK   7603   0.016   0.030          TRAP     25      2

160     KK   SUB14
161     BA   0.707
162     LS      0      98             0     84
163     UK     75    .005    .050    35
164     UK    200    .005     .10    65
165     RK   5600     .02    .020   .29   TRAP      5      2
166     RK   5400    .008    .035          TRAP     30      2     NO

167     KK    CB12,13&14
168     HC      4
169     ZZ
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
				6-HOUR	24-HOUR	72-HOUR			
HYDROGRAPH AT	SUB8	233.	12.50	41.	12.	11.	.17		
ROUTED TO	ROUTE	232.	12.50	41.	12.	11.	.17		
								11.42	12.50
ROUTED TO	R8-9	229.	12.57	41.	12.	11.	.17		
HYDROGRAPH AT	SUB7	59.	12.50	10.	3.	3.	.04		
ROUTED TO	ROUTE	49.	12.57	10.	3.	3.	.04		
								16.67	12.57
ROUTED TO	R7-9	48.	12.63	10.	3.	3.	.04		
HYDROGRAPH AT	SUB9	455.	12.53	70.	20.	18.	.38		
3 COMBINED AT	CB7&8&9	730.	12.53	121.	34.	31.	.60		
ROUTED TO	ROUTE	724.	12.60	122.	35.	31.	.60		
HYDROGRAPH AT	SUB3	35.	12.50	6.	2.	2.	.02		
ROUTED TO	R3-12	35.	12.60	6.	2.	2.	.02		
HYDROGRAPH AT	SUB4	308.	12.50	53.	15.	14.	.21		
ROUTED TO	R4-12	307.	12.53	53.	15.	14.	.21		
HYDROGRAPH AT	SUB5	40.	12.50	7.	2.	2.	.03		
ROUTED TO	ROUTE	33.	12.57	7.	2.	2.	.03		

								22.23	12.57
ROUTED TO	R5-12	33.	12.67	7.	2.	2.	.03		
HYDROGRAPH AT	SUB6	177.	12.50	32.	9.	8.	.12		
ROUTED TO	ROUTE	175.	12.50	32.	9.	8.	.12		
								11.11	12.50
ROUTED TO	R6-12	175.	12.60	32.	9.	8.	.12		
HYDROGRAPH AT	SUB10	700.	12.50	125.	36.	32.	.50		
ROUTED TO	R10-12	692.	12.53	125.	36.	32.	.50		
HYDROGRAPH AT	SUB11	911.	12.53	164.	46.	41.	.63		
ROUTED TO	R11-12	911.	12.57	164.	46.	41.	.63		
HYDROGRAPH AT	SUB12	1868.	12.50	335.	96.	86.	1.30		
8 COMBINED AT	COMBINE	4693.	12.50	843.	240.	216.	3.40		
ROUTED TO	R12-13	4692.	12.53	844.	240.	216.	3.40		
HYDROGRAPH AT	SUB13	529.	12.50	93.	27.	24.	.38		
2 COMBINED AT	CB12&13	5212.	12.53	937.	266.	240.	3.78		
ROUTED TO	R13-14	5208.	12.60	941.	267.	241.	3.78		
HYDROGRAPH AT	SUB1	484.	12.67	102.	28.	26.	.37		
ROUTED TO	ROUTE	484.	12.70	100.	28.	25.	.37		
								14.00	12.70
ROUTED TO	R1-14	476.	12.80	100.	28.	25.	.37		
HYDROGRAPH AT	SUB2	76.	12.50	13.	4.	3.	.05		

ROUTED TO	ROUTE	12.	12.90	9.	3.	3.	.05	14.34	12.93
ROUTED TO	R2-14	12.	13.63	9.	3.	3.	.05		
HYDROGRAPH AT	SUB14	975.	12.50	177.	51.	46.	.71		
4 COMBINED AT	CB1	6540.	12.57	1225.	349.	315.	4.91		

APPENDIX E

FCD Kinematic wave model of
Cudia City Wash--
Sensitivity to overland flow plane slope

*** FREE ***

```
ID   CUDIA CITY WASH
ID   RUNOFF ANALYSIS USING THE COP STORM DISTRIBUTION
ID   ASSUME 65% PERVIOUS, PERVIOUS SLOPE = .010, PERVIOUS N = .10
IT       2 11MAR87    1200     800
IO       5

KK    SUB8
BA   0.169
IN      30
PB    4.04
PC     .00      .02      .03      .05      .07      .09      .11      .13      .14      .16
PC     .18      .19      .21      .23      .25      .27      .29      .30      .32      .38
PC     .43      .48      .57      .69     2.02     3.35     3.47     3.56     3.61     3.66
PC    3.72     3.73     3.75     3.77     3.79     3.81     3.83     3.84     3.86     3.88
PC    3.89     3.91     3.93     3.95     3.97     3.99     4.00     4.02     4.04     4.04
LS       0       98                0       81        0
UK      75     .005     .050       35
UK     200     .010      .10       65
RK     300      .05     .020      .06     TRAP        5        2
RK    4200      .05     .035             TRAP       15        2       NO

KK   ROUTE
RS       1     STOR        0
SV       0     2.05
SE       1       10
SQ       0      115
ST      10       95    0.611      1.5

KK    R8-9
RK    4700    0.016    0.035             TRAP       15        2

KK    SUB7
BA    .043
LS       0       98                0     80.0        0
UK      75     .005     .050       35
UK     200     .010      .10       65
RK     400      .04     .020     .013     TRAP        5        2
RK    2000      .03     .035             TRAP       15        2       NO
```

```
35        KK   ROUTE
36        RS      1    STOR       0
37        SV      0    0.78
38        SE      1      10
39        SQ      0      28

40        KK    R7-9
41        RK    2480   0.018   0.035            TRAP     5     2

42        KK    SUB9
43        BA   0.384
44        LS      0      79
45        UK    200    .005     .10     100
46        RK    400     .04    .020     .14    TRAP     5     2
47        RK   5200     .04    .035            TRAP    15     2     NO
48        KK    CB7&8&9

49        HC      3

50        KK   ROUTE
51        RK   2500   0.008   0.035            TRAP     5     2

52        KK    SUB3
53        BA   0.025
54        LS      0      98               0    80.0
55        UK     75    .005    .050      35
56        UK    100    .010     .10      65
57        RK    200     .08    .020    .012    TRAP     5     2
58        RK   1000     .05    .035            TRAP    15     2     NO

59        KK   R3-12
60        RK   3700   0.016   0.035            TRAP    10     2

61        KK    SUB4
62        BA   0.213
63        LS      0      98               0    82.0     0
64        UK     75    .005    .050      35
65        UK    200    .010     .10      65
66        RK    800     .05    .020     .08    TRAP     5     2
67        RK   3400     .06    .035            TRAP    15     2     NO
```

```
68      KK   R4-12
69      RK    3590   0.014   0.035           TRAP     10      2

70      KK    SUB5
71      BA   0.028
72      LS       0      98              0   80.0
73      UK      75    .005    .050     35
74      UK     100    .010     .10     65
75      RK     200     .04    .020   .006   TRAP      5      2
76      RK     800    .013    .035           TRAP     15      2      NO

77      KK   ROUTE
78      RS       1    STOR       0
79      SV       0    0.42
80      SE       1      10
81      SQ       0      14

82      KK   R5-12
83      RK    3590   0.014   0.035           TRAP      5      2

84      KK    SUB6
85      BA   0.123
86      LS       0      98              0   84.00
87      UK      75    .005    .050     35
88      UK     200    .010     .10     65
89      RK     400     .05    .020    .04   TRAP      5      2
90      RK    3200    .026    .035           TRAP     15      2      NO

91      KK   ROUTE
92      RS       1    STOR       0
93      SV       0    0.69
94      SE       1      10
95      SQ       0     156

96      KK   R6-12
97      RK    3590   0.009   0.035           TRAP     15      2
```

```
KK   SUB10
BA   0.495
LS       0      98              0    83.0       0
UK      75    .005    .050     35
UK     200    .010     .10     65
RK    1300    .050     .02    .18    TRAP       5       2
RK    5800    .024    .035           TRAP      15       2      NO

KK  R10-12
RK    5016   0.008   0.030           TRAP      15       2

KK   SUB11
BA   0.625
LS       0    87.5
UD   0.212

KK  R11-12
RK    3700   0.009   0.035           TRAP      15       2

KK   SUB12
BA    1.30
LS       0      98              0   84.00       0
UK      75    .005    .050     35
UK     200    .010     .10     65
RK    1300    .035    .020    .41    TRAP      10       2
RK    4800    .007    .035           TRAP      25       2      NO

KK COMBINE
HC       8

KK  R12-13
RK    2000   0.007   0.035           TRAP      20       2

KK   SUB13
BA   0.378
LS       0      98              0   82.00       0
UK      75    .005    .050     35
UK     200    .010     .10     65
RK    1000    .106    .020    .13    TRAP      10       2
RK    4600    .045    .035           TRAP      35       2      NO
```

```
KK CB12&13
HC       2

KK  R13-14
RK    5597   0.009   0.035           TRAP     25      2

KK    SUB1
BA    0.37
LS       0      89
UD    0.47

KK   ROUTE
RS       1    STOR       0
SV       0    2.05
SE       1      10
SQ       0      13
ST      10      95   0.611     1.5

KK   R1-14
RK    7500   0.020   0.035           TRAP     25      2

KK    SUB2
BA   0.054
LS       0      98              0   80.0      0
UK      75    .005    .050     35
UK     200    .010     .10     65
RK     300      .1     .02    .02   TRAP      5      2
RK    1200     .05    .035           TRAP     10      2     NO

KK   ROUTE
RS       1    STOR       0
SV       0    3.28
SE       1      10
SQ       0       8

KK   R2-14
RK    7600   0.016   0.035           TRAP     25      2
```

```
161     KK   SUB14
162     BA   0.707
163     LS      0      98              0      84
164     UK     75    .005    .050     35
165     UK    200    .010     .10     65
166     RK   1500     .02    .020    .29   TRAP      5      2
167     RK   5400    .008    .035          TRAP     30      2     NO

168     KK    CB12,13&14
169     HC      4
170     ZZ
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	SUB8	234.	12.50	41.	12.	11.	.17		
ROUTED TO	ROUTE	233.	12.50	41.	12.	11.	.17		
ROUTED TO	R8-9	231.	12.60	41.	12.	11.	.17	11.43	12.50
HYDROGRAPH AT	SUB7	59.	12.50	10.	3.	3.	.04		
ROUTED TO	ROUTE	49.	12.57	10.	3.	3.	.04		
ROUTED TO	R7-9	49.	12.63	10.	3.	3.	.04	16.87	12.57
HYDROGRAPH AT	SUB9	455.	12.53	70.	20.	18.	.38		
3 COMBINED AT	CB7&8&9	732.	12.53	121.	34.	31.	.60		
ROUTED TO	ROUTE	729.	12.60	122.	35.	31.	.60		
HYDROGRAPH AT	SUB3	36.	12.50	6.	2.	2.	.02		
ROUTED TO	R3-12	35.	12.60	6.	2.	2.	.02		
HYDROGRAPH AT	SUB4	310.	12.50	54.	15.	14.	.21		
ROUTED TO	R4-12	308.	12.53	54.	15.	14.	.21		
HYDROGRAPH AT	SUB5	40.	12.50	7.	2.	2.	.03		

ROUTED TO	ROUTE	33.	12.53	7.	2.	2.	.03		
								22.36	12.53
ROUTED TO	R5-12	33.	12.67	7.	2.	2.	.03		
HYDROGRAPH AT	SUB6	178.	12.50	32.	9.	8.	.12		
ROUTED TO	ROUTE	176.	12.50	32.	9.	8.	.12		
								11.15	12.50
ROUTED TO	R6-12	175.	12.60	32.	9.	8.	.12		
HYDROGRAPH AT	SUB10	704.	12.50	125.	36.	32.	.50		
ROUTED TO	R10-12	697.	12.53	125.	36.	32.	.50		
HYDROGRAPH AT	SUB11	911.	12.53	164.	46.	41.	.63		
ROUTED TO	R11-12	910.	12.57	164.	46.	41.	.63		
HYDROGRAPH AT	SUB12	1876.	12.50	337.	96.	87.	1.30		
8 COMBINED AT	COMBINE	4705.	12.50	846.	241.	217.	3.40		
ROUTED TO	R12-13	4702.	12.53	847.	241.	217.	3.40		
HYDROGRAPH AT	SUB13	532.	12.50	94.	27.	24.	.38		
2 COMBINED AT	CB12&13	5215.	12.53	940.	268.	241.	3.78		
ROUTED TO	R13-14	5212.	12.57	940.	267.	241.	3.78		
HYDROGRAPH AT	SUB1	484.	12.67	102.	28.	26.	.37		
ROUTED TO	ROUTE	484.	12.70	100.	28.	25.	.37		
								14.00	12.70
ROUTED TO	R1-14	479.	12.80	100.	28.	25.	.37		

HYDROGRAPH AT	SUB2	76.	12.50	13.	4.	3.	.05		
ROUTED TO	ROUTE	12.	12.87	9.	3.	3.	.05	14.44	12.87
ROUTED TO	R2-14	12.	13.67	9.	3.	3.	.05		
HYDROGRAPH AT	SUB14	1015.	12.50	183.	52.	47.	.71		
4 COMBINED AT	CB1	6587.	12.53	1229.	351.	316.	4.91		

APPENDIX F

FCD Kinematic wave model of
Cudia City Wash--
Sensitivity to overland flow plane roughness

*** FREE ***

```
ID   CUDIA CITY WASH
ID   RUNOFF ANALYSIS USING THE COP STORM DISTRIBUTION
ID   ASSUME 80% PERVIOUS, PERVIOUS SLOPE = .005, PERVIOUS N = .10
IT       2 11MAR87    1200     800
IO       5

KK    SUB8
BA   0.169
IN      30
PB    4.04
PC     .00     .02     .03     .05     .07     .09     .11     .13     .14     .16
PC     .18     .19     .21     .23     .25     .27     .29     .30     .32     .38
PC     .43     .48     .57     .69    2.02    3.35    3.47    3.56    3.61    3.66
PC    3.72    3.73    3.75    3.77    3.79    3.81    3.83    3.84    3.86    3.88
PC    3.89    3.91    3.93    3.95    3.97    3.99    4.00    4.02    4.04    4.04
LS       0      96               0      85       0
UK      75    .005    .050      20
UK     200    .005     .10      80
RK     300     .05    .020     .06    TRAP       5       2
RK    4200     .05    .035          TRAP      15       2      NO

KK   ROUTE
RS       1    STOR       0
SV       0    2.05
SE       1      10
SQ       0     115
ST      10      95   0.611     1.5

KK    R8-9
RK    4700   0.016   0.035          TRAP      15       2

KK    SUB7
BA    .043
LS       0      96               0    83.5       0
UK      75    .005    .050      20
UK     200    .005     .10      80
RK     400     .04    .020    .013    TRAP       5       2
RK    2000     .03    .035          TRAP      15       2      NO
```

```
35        KK   ROUTE
36        RS       1    STOR       0
37        SV       0    0.78
38        SE       1      10
39        SQ       0      28

40        KK    R7-9
41        RK    2480   0.018   0.035            TRAP      5       2

42        KK    SUB9
43        BA   0.384
44        LS       0      79
45        UK     200    .005     .10     100
46        RK     400     .04    .020     .14   TRAP      5       2
47        RK    5200     .04    .035            TRAP     15       2      NO
48        KK CB7&8&9
49        HC       3

50        KK   ROUTE
51        RK    2500   0.008   0.035            TRAP      5       2

52        KK    SUB3
53        BA   0.025
54        LS       0      96              0    83.5
55        UK      75    .005    .050      20
56        UK     100    .005     .10      80
57        RK     200     .08    .020    .012   TRAP      5       2
58        RK    1000     .05    .035            TRAP     15       2      NO

59        KK   R3-12
60        RK    3700   0.016   0.035            TRAP     10       2

61        KK    SUB4
62        BA   0.213
63        LS       0      96              0   83.75      0
64        UK      75    .005    .050      20
65        UK     200    .005     .10      80
66        RK     800     .05    .020     .08   TRAP      5       2
67        RK    3400     .06    .035            TRAP     15       2      NO
```

```
68      KK   R4-12
69      RK    3590   0.014   0.035          TRAP    10     2

70      KK   SUB5
71      BA   0.028
72      LS       0      96             0    83.5
73      UK      75    .005    .050    20
74      UK     100    .005     .10    80
75      RK     200     .04    .020  .006    TRAP     5     2
76      RK     800    .013    .035          TRAP    15     2     NO

77      KK   ROUTE
78      RS       1    STOR       0
79      SV       0    0.42
80      SE       1      10
81      SQ       0      14

82      KK   R5-12
83      RK    3590   0.014   0.035          TRAP     5     2

84      KK   SUB6
85      BA   0.123
86      LS       0      96             0   87.25
87      UK      75    .005    .050    20
88      UK     200    .005     .10    80
89      RK     400     .05    .020   .04    TRAP     5     2
90      RK    3200    .026    .035          TRAP    15     2

91      KK   ROUTE
92      RS       1    STOR       0
93      SV       0    0.69
94      SE       1      10
95      SQ       0     156

96      KK   R6-12
97      RK    3590   0.009   0.035          TRAP    15     2
```

```
KK   SUB10
BA   0.495
LS       0     96              0   86.5     0
UK      75   .005    .050    20
UK     200   .005     .10    80
RK    1300   .050     .02   .18   TRAP     5     2
RK    5800   .024    .035         TRAP    15     2     NO

KK  R10-12
RK    5016  0.008   0.030         TRAP    15     2

KK   SUB11
BA   0.625
LS       0   87.5
UD   0.212

KK  R11-12
RK    3700  0.009   0.035         TRAP    15     2

KK   SUB12
BA    1.30
LS       0     96              0  86.88     0
UK      75   .005    .050    20
UK     200   .005     .10    80
RK    1300   .035    .020   .41   TRAP    10     2
RK    4800   .007    .035         TRAP    25     2     NO

KK COMBINE
HC       8

KK  R12-13
RK    2000  0.007   0.035         TRAP    20     2

KK   SUB13
BA   0.378
LS       0     96              0  85.75     0
UK      75   .005    .050    20
UK     200   .005     .10    80
RK    1000   .106    .020   .13   TRAP    10     2
RK    4600   .045    .035         TRAP    35     2     NO
```

```
KK CB12&13
HC       2

KK  R13-14
RK    5597   0.009   0.035           TRAP     25      2

KK    SUB1
BA    0.37
LS       0      89
UD    0.47

KK   ROUTE
RS       1    STOR       0
SV       0    2.05
SE       1      10
SQ       0      13
ST      10      95   0.611     1.5

KK   R1-14
RK    7500   0.020   0.035           TRAP     25      2

KK    SUB2
BA   0.054
LS       0      96              0   83.5      0
UK      75    .005    .050     20
UK     200    .005     .10     80
RK     300      .1     .02    .02   TRAP      5      2
RK    1200     .05    .035          TRAP     10      2     NO

KK   ROUTE
RS       1    STOR       0
SV       0    3.28
SE       1      10
SQ       0       8

KK   R2-14
RK    7600   0.016   0.035           TRAP     25      2
```

```
KK   SUB14
BA   0.707
LS      0      96                0      87
UK     75    .005    .050       20
UK    200    .005     .10       80
RK   1500     .02    .020      .29   TRAP      5      2
RK   5400    .008    .035            TRAP     30      2      NO

KK    CB12,13&14
HC      4
ZZ
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
				6-HOUR	24-HOUR	72-HOUR			
HYDROGRAPH AT	SUB8	240.	12.50	42.	12.	11.	.17		
ROUTED TO	ROUTE	239.	12.50	42.	12.	11.	.17		
								11.48	12.50
ROUTED TO	R8-9	237.	12.57	42.	12.	11.	.17		
HYDROGRAPH AT	SUB7	60.	12.50	10.	3.	3.	.04		
ROUTED TO	ROUTE	49.	12.57	10.	3.	3.	.04		
								16.76	12.57
ROUTED TO	R7-9	49.	12.63	10.	3.	3.	.04		
HYDROGRAPH AT	SUB9	455.	12.53	70.	20.	18.	.38		
3 COMBINED AT	CB7&8&9	736.	12.53	122.	34.	31.	.60		
ROUTED TO	ROUTE	734.	12.60	123.	34.	31.	.60		
HYDROGRAPH AT	SUB3	36.	12.50	6.	2.	2.	.02		
ROUTED TO	R3-12	36.	12.60	6.	2.	2.	.02		
HYDROGRAPH AT	SUB4	306.	12.50	52.	15.	13.	.21		
ROUTED TO	R4-12	304.	12.53	52.	15.	13.	.21		
HYDROGRAPH AT	SUB5	40.	12.50	7.	2.	2.	.03		
ROUTED TO	ROUTE	33.	12.53	7.	2.	2.	.03		
								22.42	12.53

ROUTED TO	R5-12	33.	12.67	7.	2.	2.	.03		
HYDROGRAPH AT	SUB6	181.	12.50	32.	9.	8.	.12		
ROUTED TO	ROUTE	179.	12.50	32.	9.	8.	.12		
								11.34	12.50
ROUTED TO	R6-12	178.	12.60	32.	9.	8.	.12		
HYDROGRAPH AT	SUB10	718.	12.50	127.	36.	32.	.50		
ROUTED TO	R10-12	711.	12.53	127.	36.	32.	.50		
HYDROGRAPH AT	SUB11	911.	12.53	164.	46.	41.	.63		
ROUTED TO	R11-12	910.	12.57	164.	46.	41.	.63		
HYDROGRAPH AT	SUB12	1899.	12.50	338.	95.	86.	1.30		
8 COMBINED AT	COMBINE	4746.	12.50	848.	238.	214.	3.40		
ROUTED TO	R12-13	4741.	12.53	850.	238.	215.	3.40		
HYDROGRAPH AT	SUB13	544.	12.50	95.	27.	24.	.38		
2 COMBINED AT	CB12&13	5264.	12.53	945.	265.	239.	3.78		
ROUTED TO	R13-14	5262.	12.57	945.	264.	238.	3.78		
HYDROGRAPH AT	SUB1	484.	12.67	102.	28.	26.	.37		
ROUTED TO	ROUTE	484.	12.70	100.	28.	25.	.37		
								14.00	12.70
ROUTED TO	R1-14	479.	12.80	100.	28.	25.	.37		
HYDROGRAPH AT	SUB2	77.	12.50	13.	4.	3.	.05		
ROUTED TO	ROUTE	12.	12.97	9.	3.	3.	.05		
								14.04	12.97
ROUTED TO	R2-14	11.	13.77	9.	3.	3.	.05		

HYDROGRAPH AT	SUB14	1029.	12.50	184.	52.	46.	.71
4 COMBINED AT	CB1	6649.	12.53	1235.	347.	313.	4.91

APPENDIX G

FCD Kinematic wave model of
Cudia City Wash--
Sensitivity to percent impervious

*** FREE ***

```
 1   ID   CUDIA CITY WASH
 2   ID   RUNOFF ANALYSIS USING THE COP STORM DISTRIBUTION
 3   ID   ASSUME 65% PERVIOUS, PERVIOUS SLOPE = .005, PERVIOUS N = .15
 4   IT       2 11MAR87    1200     800
 5   IO       5

 6   KK   SUB8
 7   BA   0.169
 8   IN      30
 9   PB    4.04
10   PC     .00      .02      .03      .05      .07      .09      .11      .13      .14      .16
11   PC     .18      .19      .21      .23      .25      .27      .29      .30      .32      .38
12   PC     .43      .48      .57      .69     2.02     3.35     3.47     3.56     3.61     3.66
13   PC    3.72     3.73     3.75     3.77     3.79     3.81     3.83     3.84     3.86     3.88
14   PC    3.89     3.91     3.93     3.95     3.97     3.99     4.00     4.02     4.04     4.04
15   LS       0       98                0       81        0
16   UK      75     .005     .050       35
17   UK     200     .005      .15       65
18   RK     300      .05     .020      .06     TRAP        5        2
19   RK    4200      .05     .035             TRAP       15        2       NO

20   KK   ROUTE
21   RS       1     STOR        0
22   SV       0     2.05
23   SE       1       10
24   SQ       0      115
25   ST      10       95    0.611      1.5

26   KK   R8-9
27   RK    4700    0.016    0.035             TRAP       15        2

28   KK   SUB7
29   BA   .043
30   LS       0       98                0     80.0        0
31   UK      75     .005     .050       35
32   UK     200     .005      .15       65
33   RK     400      .04     .020     .013     TRAP        5        2
34   RK    2000      .03     .035             TRAP       15        2       NO
```

```
35      KK   ROUTE
36      RS       1    STOR       0
37      SV       0    0.78
38      SE       1      10
39      SQ       0      28

40      KK    R7-9
41      RK    2480   0.018   0.035           TRAP      5      2

42      KK    SUB9
43      BA   0.384
44      LS       0      79
45      UK     200    .005     .10     100
46      RK     400     .04    .020     .14   TRAP      5      2
47      RK    5200     .04    .035           TRAP     15      2     NO

48      KK CB7&8&9
49      HC       3

50      KK   ROUTE
51      RK    2500   0.008   0.035           TRAP      5      2

52      KK    SUB3
53      BA   0.025
54      LS       0      98       .        0   80.0
55      UK      75    .005    .050      35
56      UK     100    .005     .15      65
57      RK     200     .08    .020    .012   TRAP      5      2
58      RK    1000     .05    .035           TRAP     15      2     NO

59      KK   R3-12
60      RK    3700   0.016   0.035           TRAP     10      2
```

```
KK    SUB4
BA    0.213
LS      0     98              0    82.0      0
UK     75   .005    .050     35
UK    200   .005     .15     65
RK    800    .05    .020    .08    TRAP      5      2
RK   3400    .06    .035           TRAP     15      2     NO

KK    R4-12
RK   3590  0.014   0.035           TRAP     10      2

KK    SUB5
BA    0.028
LS      0     98              0    80.0
UK     75   .005    .050     35
UK    100   .005     .15     65
RK    200    .04    .020   .006    TRAP      5      2
RK    800   .013    .035           TRAP     15      2     NO

KK    ROUTE
RS      1   STOR       0
SV      0   0.42
SE      1     10
SQ      0     14

KK    R5-12
RK   3590  0.014   0.035           TRAP      5      2

KK    SUB6
BA    0.123
LS      0     98              0   84.00
UK     75   .005    .050     35
UK    200   .005     .15     65
RK    400    .05    .020    .04    TRAP      5      2
RK   3200   .026    .035           TRAP     15      2     NO
KK    ROUTE
RS      1   STOR       0
SV      0   0.69
SE      1     10
SQ      0    156
```

```
KK   R6-12
RK    3590   0.009   0.035           TRAP     15      2

KK   SUB10
BA   0.495
LS       0      98              0   83.0      0
UK      75    .005    .050     35
UK     200    .005     .15     65
RK    1300    .050     .02    .18   TRAP      5      2
RK    5800    .024    .035           TRAP     15      2      NO

KK  R10-12
RK    5016   0.008   0.030           TRAP     15      2

KK   SUB11
BA   0.625
LS       0    87.5
UD   0.212

KK  R11-12
RK    3700   0.009   0.035           TRAP     15      2

KK   SUB12
BA    1.30
LS       0      98              0  84.00      0
UK      75    .005    .050     35
UK     200    .005     .15     65
RK    1300    .035    .020    .41   TRAP     10      2
RK    4800    .007    .035           TRAP     25      2      NO

KK COMBINE
HC       8

KK  R12-13
RK    2000   0.007   0.035           TRAP     20      2
```

```
KK   SUB13
BA   0.378
LS       0      98              0   82.00       0
UK      75    .005    .050     35
UK     200    .005     .15     65
RK    1000    .106    .020    .13    TRAP      10       2
RK    4600    .045    .035           TRAP      35       2      NO
KK CB12&13
HC       2

KK  R13-14
RK    5597   0.009   0.035           TRAP      25       2

KK    SUB1
BA    0.37
LS       0      89
UD    0.47

KK   ROUTE
RS       1    STOR       0
SV       0    2.05
SE       1      10
SQ       0      13
ST      10      95   0.611     1.5

KK   R1-14
RK    7500   0.020   0.035           TRAP      25       2

KK    SUB2
BA   0.054
LS       0      98              0   80.0       0
UK      75    .005    .050     35
UK     200    .005     .15     65
RK     300      .1     .02    .02    TRAP       5       2
RK    1200     .05    .035           TRAP      10       2      NO
```

```
KK   ROUTE
RS      1    STOR      0
SV      0    3.28
SE      1      10
SQ      0       8

KK   R2-14
RK   7600   0.016   0.035          TRAP     25      2

KK   SUB14
BA   0.707
LS      0      98             0     84
UK     75    .005    .050    35
UK    200    .005     .15    65
RK   1500     .02    .020   .29   TRAP      5      2
RK   5400    .008    .035          TRAP     30      2     NO

KK    CB12,13&14
HC      4
ZZ
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	SUB8	231.	12.50	41.	12.	11.	.17		
ROUTED TO	ROUTE	230.	12.50	41.	12.	11.	.17	11.40	12.50
ROUTED TO	R8-9	228.	12.60	41.	12.	11.	.17		
HYDROGRAPH AT	SUB7	58.	12.50	10.	3.	3.	.04		
ROUTED TO	ROUTE	47.	12.57	10.	3.	3.	.04	16.23	12.57
ROUTED TO	R7-9	47.	12.63	10.	3.	3.	.04		
HYDROGRAPH AT	SUB9	455.	12.53	70.	20.	18.	.38		
3 COMBINED AT	CB7&8&9	724.	12.53	121.	34.	31.	.60		
ROUTED TO	ROUTE	722.	12.60	122.	35.	31.	.60		
HYDROGRAPH AT	SUB3	35.	12.50	6.	2.	2.	.02		
ROUTED TO	R3-12	35.	12.60	6.	2.	2.	.02		
HYDROGRAPH AT	SUB4	306.	12.50	53.	15.	14.	.21		
ROUTED TO	R4-12	304.	12.53	53.	15.	14.	.21		
HYDROGRAPH AT	SUB5	40.	12.50	7.	2.	2.	.03		

ROUTED TO	ROUTE	33.	12.57	7.	2.	2.	.03		
								21.98	12.57
ROUTED TO	R5-12	32.	12.70	7.	2.	2.	.03		
HYDROGRAPH AT	SUB6	176.	12.50	32.	9.	8.	.12		
ROUTED TO	ROUTE	174.	12.53	32.	9.	8.	.12		
								11.04	12.53
ROUTED TO	R6-12	173.	12.60	32.	9.	8.	.12		
HYDROGRAPH AT	SUB10	695.	12.50	125.	36.	32.	.50		
ROUTED TO	R10-12	687.	12.57	125.	36.	32.	.50		
HYDROGRAPH AT	SUB11	911.	12.53	164.	46.	41.	.63		
ROUTED TO	R11-12	910.	12.57	164.	46.	41.	.63		
HYDROGRAPH AT	SUB12	1857.	12.50	336.	96.	87.	1.30		
8 COMBINED AT	COMBINE	4659.	12.53	844.	240.	217.	3.40		
ROUTED TO	R12-13	4656.	12.53	845.	241.	217.	3.40		
HYDROGRAPH AT	SUB13	526.	12.50	94.	27.	24.	.38		
2 COMBINED AT	CB12&13	5172.	12.53	939.	268.	241.	3.78		
ROUTED TO	R13-14	5166.	12.57	939.	267.	241.	3.78		
HYDROGRAPH AT	SUB1	484.	12.67	102.	28.	26.	.37		
ROUTED TO	ROUTE	484.	12.70	100.	28.	25.	.37		
								14.00	12.70
ROUTED TO	R1-14	479.	12.80	100.	28.	25.	.37		
HYDROGRAPH AT	SUB2	75.	12.50	13.	4.	3.	.05		

ROUTED TO	ROUTE	12.	13.03	9.	3.	3.	.05		
ROUTED TO	R2-14	12.	13.77	9.	3.	3.	.05	14.14	13.03
HYDROGRAPH AT	SUB14	1003.	12.50	183.	52.	47.	.71		
4 COMBINED AT	CB1	6521.	12.53	1227.	351.	316.	4.91		

APPENDIX H

FCD Kinematic wave model of
Cudia City Wash--
Sensitivity to combined effects of
slope, roughness and percent impervious

*** FREE ***

```
ID   CUDIA CITY WASH
ID   RUNOFF ANALYSIS USING THE COP STORM DISTRIBUTION
ID   ASSUME 80% PERVIOUS, PERVIOUS SLOPE = .010, PERVIOUS N = .15
IT       2 11MAR87    1200     800
IO       5

KK    SUB8
BA   0.169
IN      30
PB    4.04
PC     .00     .02     .03     .05     .07     .09     .11     .13     .14     .16
PC     .18     .19     .21     .23     .25     .27     .29     .30     .32     .38
PC     .43     .48     .57     .69    2.02    3.35    3.47    3.56    3.61    3.66
PC    3.72    3.73    3.75    3.77    3.79    3.81    3.83    3.84    3.86    3.88
PC    3.89    3.91    3.93    3.95    3.97    3.99    4.00    4.02    4.04    4.04
LS       0      96               0      85       0
UK      75    .005    .050      20
UK     200    .010     .15      80
RK     300     .05    .020     .06    TRAP       5       2
RK    4200     .05    .035          TRAP      15       2      NO

KK   ROUTE
RS       1    STOR       0
SV       0    2.05
SE       1      10
SQ       0     115
ST      10      95   0.611     1.5

KK    R8-9
RK    4700   0.016   0.035          TRAP      15       2

KK    SUB7
BA    .043
LS       0      96               0    83.5       0
UK      75    .005    .050      20
UK     200    .010     .15      80
RK     400     .04    .020    .013    TRAP       5       2
RK    2000     .03    .035          TRAP      15       2      NO
```

```
35      KK   ROUTE
36      RS      1    STOR      0
37      SV      0    0.78
38      SE      1      10
39      SQ      0      28

40      KK    R7-9
41      RK    2480   0.018   0.035          TRAP     5     2

42      KK    SUB9
43      BA   0.384
44      LS      0      79
45      UK    200    .005     .10    100
46      RK    400     .04    .020    .14   TRAP     5     2
47      RK   5200     .04    .035           TRAP    15     2     NO                    LINE
48      KK CB7&8&9
49      HC      3

50      KK   ROUTE
51      RK   2500   0.008   0.035          TRAP     5     2

52      KK    SUB3
53      BA   0.025
54      LS      0      96              0   83.5
55      UK     75    .005    .050     20
56      UK    100    .010     .15     80
57      RK    200     .08    .020   .012   TRAP     5     2
58      RK   1000     .05    .035           TRAP    15     2     NO

59      KK   R3-12
60      RK   3700   0.016   0.035          TRAP    10     2

61      KK    SUB4
62      BA   0.213
63      LS      0      96              0   83.75    0
64      UK     75    .005    .050     20
65      UK    200    .010     .15     80
66      RK    800     .05    .020    .08   TRAP     5     2
67      RK   3400     .06    .035           TRAP    15     2     NO
```

```
68      KK   R4-12
69      RK    3590   0.014   0.035          TRAP    10     2

70      KK    SUB5
71      BA   0.028
72      LS       0      96            0    83.5
73      UK      75    .005    .050   20
74      UK     100    .010     .15   80
75      RK     200     .04    .020  .006   TRAP     5     2
76      RK     800    .013    .035          TRAP    15     2     NO

77      KK   ROUTE
78      RS       1    STOR       0
79      SV       0    0.42
80      SE       1      10
81      SQ       0      14

82      KK   R5-12
83      RK    3590   0.014   0.035          TRAP     5     2

84      KK    SUB6
85      BA   0.123
86      LS       0      96            0   87.25
87      UK      75    .005    .050   20
88      UK     200    .010     .15   80
89      RK     400     .05    .020  .04   TRAP     5     2
90      RK    3200    .026    .035          TRAP    15     2     NO

91      KK   ROUTE
92      RS       1    STOR       0
93      SV       0    0.69
94      SE       1      10
95      SQ       0     156

96      KK   R6-12
97      RK    3590   0.009   0.035          TRAP    15     2
```

98	KK	SUB10							
99	BA	0.495							
100	LS	0	96		0	86.5	0		
101	UK	75	.005	.050	20				
102	UK	200	.010	.15	80				
103	RK	1300	.050	.02	.18	TRAP	5	2	
104	RK	5800	.024	.035		TRAP	15	2	NO
105	KK	R10-12							
106	RK	5016	0.008	0.030		TRAP	15	2	
107	KK	SUB11							
108	BA	0.625							
109	LS	0	87.5						
110	UD	0.212							
111	KK	R11-12							
112	RK	3700	0.009	0.035		TRAP	15	2	
113	KK	SUB12							
114	BA	1.30							
115	LS	0	96		0	86.88	0		
116	UK	75	.005	.050	20				
117	UK	200	.010	.15	80				
118	RK	1300	.035	.020	.41	TRAP	10	2	
119	RK	4800	.007	.035		TRAP	25	2	NO
120	KK	COMBINE							
121	HC	8							
122	KK	R12-13							
123	RK	2000	0.007	0.035		TRAP	20	2	

```
KK   SUB13
BA   0.378
LS       0      96              0   85.75      0
UK      75    .005    .050     20
UK     200    .010     .15     80
RK    1000    .106    .020    .13    TRAP     10      2
RK    4600    .045    .035           TRAP     35      2     NO

KK CB12&13
HC       2

KK  R13-14
RK    5597   0.009   0.035           TRAP     25      2

KK    SUB1
BA    0.37
LS       0      89
UD    0.47

KK   ROUTE
RS       1    STOR       0
SV       0    2.05
SE       1      10
SQ       0      13
ST      10      95   0.611     1.5

KK   R1-14
RK    7500   0.020   0.035           TRAP     25      2

KK    SUB2
BA   0.054
LS       0      96              0   83.5      0
UK      75    .005    .050     20
UK     200    .010     .15     80
RK     300      .1     .02    .02    TRAP      5      2
RK    1200     .05    .035           TRAP     10      2     NO
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154     KK   ROUTE
155     RS      1    STOR      0
156     SV      0    3.28
157     SE      1      10
158     SQ      0       8

159     KK   R2-14
160     RK   7600   0.016   0.035          TRAP    25     2

161     KK   SUB14
162     BA   0.707
163     LS      0      96             0     87
164     UK     75    .005    .050    20
165     UK    200    .010     .15    80
166     RK   1500     .02    .020   .29   TRAP     5     2
167     RK   5400    .008    .035         TRAP    30     2    NO

168     KK    CB12,13&14
169     HC      4
170     ZZ
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	SUB8	240.	12.50	42.	12.	11.	.17		
ROUTED TO	ROUTE	238.	12.50	42.	12.	11.	.17		
								11.48	12.50
ROUTED TO	R8-9	237.	12.57	42.	12.	11.	.17		
HYDROGRAPH AT	SUB7	60.	12.50	10.	3.	3.	.04		
ROUTED TO	ROUTE	49.	12.57	10.	3.	3.	.04		
								16.70	12.57
ROUTED TO	R7-9	48.	12.63	10.	3.	3.	.04		
HYDROGRAPH AT	SUB9	455.	12.53	70.	20.	18.	.38		
3 COMBINED AT	CB7&8&9	736.	12.53	122.	34.	31.	.60		
ROUTED TO	ROUTE	734.	12.60	123.	34.	31.	.60		
HYDROGRAPH AT	SUB3	36.	12.50	6.	2.	2.	.02		
ROUTED TO	R3-12	36.	12.60	6.	2.	2.	.02		
HYDROGRAPH AT	SUB4	306.	12.50	52.	15.	13.	.21		
ROUTED TO	R4-12	304.	12.53	52.	15.	13.	.21		
HYDROGRAPH AT	SUB5	40.	12.50	7.	2.	2.	.03		

ROUTED TO	ROUTE	33.	12.53	7.	2.	2.	.03		
								22.37	12.53
ROUTED TO	R5-12	33.	12.67	7.	2.	2.	.03		
HYDROGRAPH AT	SUB6	181.	12.50	32.	9.	8.	.12		
ROUTED TO	ROUTE	179.	12.50	32.	9.	8.	.12		
								11.33	12.50
ROUTED TO	R6-12	178.	12.60	32.	9.	8.	.12		
HYDROGRAPH AT	SUB10	717.	12.50	127.	36.	32.	.50		
ROUTED TO	R10-12	710.	12.53	127.	36.	32.	.50		
HYDROGRAPH AT	SUB11	911.	12.53	164.	46.	41.	.63		
ROUTED TO	R11-12	910.	12.57	164.	46.	41.	.63		
HYDROGRAPH AT	SUB12	1897.	12.50	338.	95.	85.	1.30		
8 COMBINED AT	COMBINE	4741.	12.50	848.	238.	214.	3.40		
ROUTED TO	R12-13	4737.	12.53	849.	238.	214.	3.40		
HYDROGRAPH AT	SUB13	543.	12.50	95.	27.	24.	.38		
2 COMBINED AT	CB12&13	5260.	12.53	945.	265.	239.	3.78		
ROUTED TO	R13-14	5257.	12.57	944.	264.	238.	3.78		
HYDROGRAPH AT	SUB1	484.	12.67	102.	28.	26.	.37		
ROUTED TO	ROUTE	484.	12.70	100.	28.	25.	.37		
								14.00	12.70
ROUTED TO	R1-14	479.	12.80	100.	28.	25.	.37		

HYDROGRAPH AT	SUB2	77.	12.50	13.	4.	3.	.05		
ROUTED TO	ROUTE	12.	13.00	9.	3.	3.	.05	14.01	13.00
ROUTED TO	R2-14	11.	13.77	9.	3.	3.	.05		
HYDROGRAPH AT	SUB14	1028.	12.50	184.	52.	46.	.71		
4 COMBINED AT	CB1	6643.	12.53	1235.	347.	313.	4.91		