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PRELIMINARY HYDROLOGY REPORT

FOR

TATUM BOULEVARD
MOCKINGBIRD LANE TO SHEA BOULEVARD

CITY OF PHOENIX

PROJECT NO. P-886515

REGISTERED PROFESSIONAL ENGINEER (CIVIL)
CERTIFICATE NO. 18153
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ARIZONA, U.S.A.

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March 30, 1990

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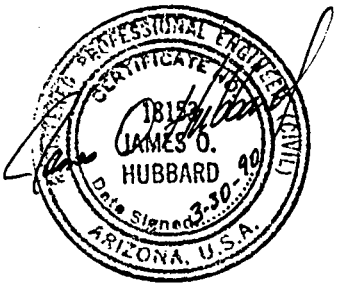

INTRODUCTION

This report presents the existing hydrologic conditions for Tatum Boulevard between Sunset Drive and Gold Dust Avenue. This section of Tatum Boulevard is within the jurisdiction of the City of Phoenix. However, the east right of way of Tatum Boulevard is also the boundary between the City of Phoenix and the Town of Paradise Valley. Tatum Boulevard will be upgraded to a six-lane arterial street (three lanes in each direction) with a raised, landscaped median.

The study area (Figure 1) is bound to the west and south by the Phoenix Mountain Preserve, to the east by Tatum Boulevard, and to the north by Gold Dust Avenue. The general flow pattern in the watershed is from west to east and intersects Tatum Boulevard transversely. Tatum Boulevard acts as a major collector of storm runoff from the west that either ponds in low points along the roadway or at street intersection, such as Double Tree Ranch Road. Eventually, the storm runoff continues eastward and outfalls into the Indian Bend Wash.

EXISTING DRAINAGE FACILITIES

There are two well-defined channels in the study area that convey storm runoff through subdivisions to Tatum Boulevard. One channel is made of gunite and drains an area of approximately 404 acres that includes Tatum Mountain Acres, Double Tree Canyon and a portion of the Phoenix Mountain Preserve. This channel eventually drains into a detention basin located west of Tatum Boulevard and south of Double Tree Ranch Road.

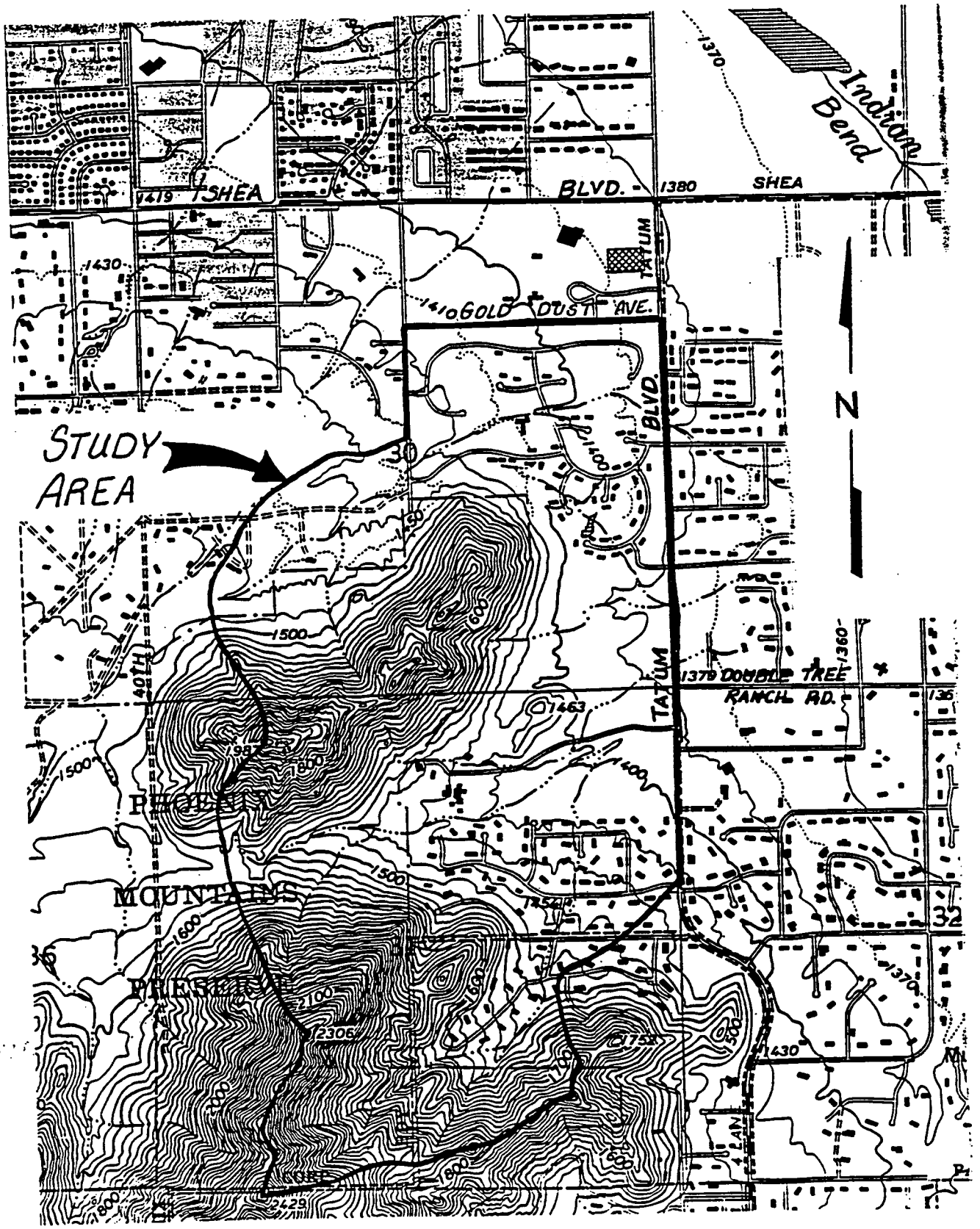
SHEA BLVD.
SHEA
Indian Bend
GOLD DUST AVE.
TATUM BLVD.
TATUM
STUDY AREA
N
40TH
DOUBLE TREE RANCH RD.
PHOENIX MOUNTAINS
PRESERVE
30
32
36
1370
1380
1419
1430
1410
1400
1500
1600
1463
1360
1430
2306
2429

FIGURE 1

The other channel is trenched through the "Rancho Alta Vida" subdivision and drains approximately 170 acres. This channel conveys storm runoff to 6-36" x 22" corrugated metal pipe arch culverts that discharge runoff under Tatum Boulevard into the "Mountain View Estates" subdivision .

Drainage from the "Tatum Foothills" subdivision is collected in retention basins located between the subdivision and the west right of way of Tatum Boulevard. There are approximately four other retention basins that collect storm runoff from the "Alta Rancho Vida" subdivision.

The only storm drain facility along Tatum Boulevard is an existing 36" storm drain trunk line that extends approximately 764 feet south of the Shea Boulevard 78" storm drain trunk line. There are three curb opening type catch basins that are interconnected to the 6-36"x22" corrugated metal pipe arch culverts to alleviate pavement drainage. Pavement drainage is also collected in sumps along the west curb and gutter and conveyed eastward across the street to curb openings or to continue flowing eastward down side streets.

The most serious flooding problems along Tatum Boulevard occur at the Double Tree Ranch Road intersection where the previously mentioned gunite channel discharges storm runoff into a detention basin that overflows onto Tatum Boulevard. This detention basin is essentially at the same elevation as Tatum Boulevard, and is insufficient to detain the necessary runoff to reduce the peak discharge. The volume of this detention basin and outlet requirements need to be evaluated in order to mitigate the impacts of drainage on Tatum Boulevard.

HYDROLOGY

The hydrologic analyses for offsite runoff was performed using the HEC-1 computer program to simulate the rainfall-runoff relationship of a drainage area and the routing of flows to selected concentration points. The drainage areas were divided into a number of sub-basins to better define the runoff process by taking into account the variations in topography and urbanization.

Plate 1 illustrates the sub-basins and points of concentration used for the HEC-1 model. The hydrographs were routed to confluences with adjacent sub-basins using the Attenuation-Kinematic and Modified Puls Method.

The peak discharges for the 2-, 10-, 50- and 100-year storm event were determined for the resulting network of sub-basins using a 1-hour and 24-hour storm duration. The City of Phoenix rainfall distribution table was used for the 24-hour storm duration. The rainfall distribution table for a 1-hour storm duration is shown in Appendix A. The City of Phoenix precipitation values were used for the 1-hour and 24-hour storm durations.

Based on the "General Soil Map of Maricopa County" by the Soil Conservation Service, the study area would be classified as a "Group D" soil. A curve number of 86 was used for residential areas and 95 for mountainous terrain with slopes greater than 10 percent. These curve numbers were applicable for the 1-hour storm duration. The curve numbers were adjusted to account for infiltration rate differences between storms of different duration. The 24-hour curve numbers were lowered to account for the greater infiltration rate associated with a longer storm duration. The curve number adjustments were interpolated from the chart shown in Appendix A.

A time of concentration for each sub-basin or drainage area was determined using the method outline in the manual "Urban Hydrology for Small Watersheds", June 1986, by the U.S. Department of Agriculture. A minimum time of concentration was set for 10 minutes.

The rational method of hydrology was used to compute the peak runoff within the study area for drainage areas less than 40 acres. The peak discharges were computed for the 2-, 10-, 50-, and 100-year storm event using the City of Phoenix rainfall intensity-duration-frequency curves. A runoff coefficient of 0.45 was used for residential areas and 0.70 for mountainous terrain with slopes greater than 10 percent.

A retention volume required for a given drainage area or sub-basin was computed using two methods. One method was to estimate the area under a hydrograph for a 2-, 10-, 50-, and 100-year storm event using a 2 hour duration storm.

$$\text{Volume in ft}^3 = Q_i \times 7200$$

The second method was similar to the first, except the computed time of concentration, Tc, for the drainage area was used in the following equation:

$$\text{Volume in ft}^3 = Q_i \times 2.67 \times Tc \times 0.5 \times 60$$

The retention volume using Method 1 was on the average 2 to 3 times greater than Method 2. The computed retention volumes were compared to the existing retention basins' volumes to determine their design frequency. The existing volumes were computed by planimetering the perimeter of the retention basins from 1" = 100' aerials and multiplying by an average depth of 3 ft.

HYDRAULICS

The HEC-5 methodology and design charts were used to determine whether existing pipe culverts were sufficient to convey the peak discharge through a roadway embankment.

HYDROLOGIC RESULTS FOR EXISTING CONDITIONS

Drainage Area No. 1

The topography of this region consists of approximately 68 percent mountainous areas and 32 percent residential areas. The mountainous areas are characterized by rugged terrain and steep gradients. Prior to development, the region contained numerous washes that flowed from the southwest to the northeast.

Plate 1 illustrates the delineation of sub-basins for Drainage Area No. 1, which encompasses approximately 404 acres. Drainage for this area is collected and conveyed by a gunite channel running though the "Double Tree Canyon" subdivision to a detention basin southwest of the Tatum Boulevard - Double Tree Ranch Road intersection.

Peak discharges for the above mentioned detention basin were estimated for return periods of 2-, 10-, 25-, 50- and 100-years using the HEC-1 computer model. The 1-hour and 24-hour storm durations were compared for the return periods to determine which governed. The peak discharge results are presented in Table 1 and the HEC-1 input and output files for the 1-hour storm duration are presented in Appendix B-1. Appendix B-2 contains the sub-basin areas, weighted curve number computations and time of concentration calculations.

STORM FREQUENCY (YR)	PEAK DISCHARGE AT DETENTION BASIN (CFS)	
	1-HR	24-HR
2	289	202
10	845	455
25	1207	598
50	1503	713
100	1749	824

TABLE 1

PEAK DISCHARGE SUMMARY FOR DRAINAGE AREA NO. 1

The peak discharge for the 1-hour storm duration was on the average almost twice the peak discharge for the 24-hour storm duration. The computed times of concentration for each sub-basin was found to be less than 10 minutes because of the high runoff potential of the soil and the steep gradients.

As mentioned previously, the existing detention basin has virtually no storage whatsoever, and therefore is not sufficient to reduce the peak discharge. Therefore, the Tatum Boulevard - Double Tree Road intersection is essentially a man-made concentration point for approximately 404 acres.

DRAINAGE AREA NO. 2

This region consists of approximately 31 percent mountainous areas and 69 percent residential areas. Prior to development, this region contained a network of numerous washes flowing from the west to east that collected at a low point adjacent to Tatum Boulevard, fronting what is now the "Tatum Foothills" subdivision.

Plate 1 illustrates the delineation of sub-basins for Drainage Area No. 2, which encompasses an area of approximately 164 acres. This region includes a portion of the Phoenix Mountain Preserve and the following subdivisions: A portion of Double Tree Canyon; Tatum Foothills; and a portion of Rancho Alta Vida. Drainage is conveyed through residential streets and eventually discharges into retention basins located between the "Tatum Foothills" subdivision and Tatum Boulevard. The "Rancho Alta Vida" subdivision has set aside common areas that either convey or retain storm runoff flowing through the subdivision.

STORM FREQUENCY (YR)	PEAK DISCHARGE (CFS) SUB-BASINS #400 & #410	
	1-HR	24-HR
2	53	40
10	176	108
25	255	147
50	321	177
100	386	209

TABLE 2

PEAK DISCHARGE SUMMARY FOR SUB-BASINS #400 AND #410

Peak discharges for sub-basins #400 and #410 were computed using the HEC-1 computer model for the 2-, 10-, 25-, 50-, and 100-year return periods. The HEC-1 analysis was used over the rational method because the corresponding drainage areas exceeded 40 acres. The peak discharges for 1-hour and 24-hour storm durations are presented in Table 2 and the HEC-1 input and output files for the 1-hour storm duration are presented in Appendix C-1.

Peak discharges for sub-basins #421 thru #423, #431 and #432 were determined using the rational method because the corresponding drainage areas were less than 40 acres. The peak discharges are presented in Table 3 for the 2-, 10-, 25-, 50- and 100-year return periods. The design calculations are presented in Appendix C-2.

Storm runoff from sub-basins #423 and #432 are collected in retention basins that have the capacity to retain the 100-year event. Therefore, these areas can be excluded from the analysis to determine the drainage impacts of Drainage Area No. 2 on Tatum Boulevard. The retention basin computations are presented in Appendix C-2.

STORM FREQUENCY (YR)	SUB-BASIN PEAK DISCHARGE (CFS)				
	#421	#422	#423	#431	#432
2	7	10	29	7	9
10	12	17	46	12	15
25	14	20	55	14	18
50	15	22	61	15	19
100	17	24	67	17	21

TABLE 3

PEAK DISCHARGE SUMMARY FOR DRAINAGE AREA NO. 2

DRAINAGE AREA NO. 3

This region contains approximately 50 percent mountainous areas and 50 percent residential areas. The mountainous areas are rugged with steep gradients sloping from south to north. Before urbanization, this region contained numerous small washes flowing from the southwest to northeast that discharged into a large wash which flowed easterly through the "Rancho Alta Vida" subdivision. This large wash intersected Tatum Boulevard perpendicularly, and thus created the main concentration point for Drainage Area No. 3.

Plate 1 illustrates the delineation of sub-basins for Drainage Area No. 3, which encompasses an area of approximately 171 acres. Drainage is collected and conveyed by a man made channel running easterly through the "Rancho Alta Vida" subdivision to 6 - 36"x22" corrugated metal pipe arch culverts that convey storm runoff under Tatum Boulevard into the "Mountain View Estates" subdivision located in the Town of Paradise Valley.

Peak discharges for Drainage Area No. 3 were computed using the HEC-1 computer model for the 2-, 10-, 25-, 50- and 100-year return periods. The peak discharges at Tatum Boulevard for the 1-hour and 24-hour storm durations are presented in Table 4 and the HEC-1 input and output files for the 24-hour storm duration are presented in Appendix D-1. Appendix D-2 contains the sub-basin areas, weighted curve number and time of concentration calculations.

STORM FREQUENCY (YR)	PEAK DISCHARGE FOR DRAINAGE AREA NO. 3 (CFS)	
	1-HR	24-HR
2	90	365
10	277	691
25	397	870
50	508	1001
100	615	1141

TABLE 4

PEAK DISCHARGE SUMMARY FOR DRAINAGE AREA NO. 3

The peak discharges for the 24-hour storm duration was on the average almost twice the value for the 1-hour storm duration. This watershed was more elongated than Drainage Area No. 1, where the 1-hour peak discharge was twice the 24-hour peak discharge. Also, the concentration point for Drainage Area No. 1 was more centrally located with respect to the surrounding sub-basins, and thus was more conducive to a quick time to peak discharge than Drainage Area No. 3. Therefore, the 1-hour storm duration would control for Drainage Area No. 1 and not for Drainage Area No. 3.

The existing 6-36"x22" corrugated metal pipe arch culverts had the capacity to convey 150 CFS without overtopping Tatum Boulevard. According to Table 4, these culverts will have to be upgraded in order to sufficiently convey the 10-year design storm. The hydraulic calculations for the existing pipe culverts are presented in Appendix D-2.

DRAINAGE AREA NO. 4

This region is 100 percent residential and encompasses an area of approximately 54 acres. Drainage is predominantly from the west to east with most runoff outfalling into retention basins located within the north half of the "Rancho Alta Vida" subdivision.

Plate 1 illustrates the delineation of sub-basins for Drainage Area No. 4. Drainage for Sub-basins #452 and #453 is collected and conveyed by residential streets to retention basins. Drainage for Sub-basin #451 eventually discharges onto Tatum Boulevard at the northeast corner of the "Rancho Alta Vida" subdivision.

Peak discharges were computed using the rational method for the 2-, 10-, 25-, 50- and 100-year storm events and are presented in Table 5. The computations are presented in Appendix E. The time of concentration, Tc, for Sub-basins #451 and #453 were each less than ten minutes and approximately 33 minutes for Sub-basin #452.

The retention basin for Sub-basin #453 has the capacity to retain the 100-year storm event, where as the basin for Sub-basin #452 has enough capacity to retain the 25-year storm event. Therefore, Sub-basin #453 can be excluded from the study when determining drainage impacts on Tatum Boulevard. Sub-basin #452 will have to be evaluated to determine if the 25-year retention capacity is enough to mitigate any drainage effects on Tatum Boulevard. The retention basin computations are presented in Appendix E.

STORM FREQUENCY (YR)	SUB-BASIN PEAK DISCHARGE (CFS)		
	#451	#452	#453
2	15	16	8
10	24	25	12
25	29	30	15
50	32	34	16
100	35	39	18

TABLE 5

PEAK DISCHARGE SUMMARY FOR DRAINAGE AREA NO. 4

SUMMARY AND CONCLUSIONS

Peak discharges for concentration points located within each drainage area have been computed and presented based on existing conditions. The main contribution of flooding by storm runoff occurs downstream of the detention basin located southwest of the Tatum Boulevard -Double Tree Ranch intersection. Based on the computed peak discharges, this detention basin is severely undersized.

The tabulated peak discharges for each drainage area needs to be evaluated by the City of Phoenix, and direction given to Kaminski-Hubbard Engineering, Inc. as to what level of protection is required for Tatum Boulevard. Obviously, it would be uneconomical for drainage facilities to be designed for the 100-year storm event.

For Drainage Area No. 1, we are recommending a detention basin with cross drainage facilities under Tatum Boulevard. An advantage of the detention basin concept is that it "meters" the flow of runoff, therefore reducing the peak discharge at Tatum Boulevard. The cross drainage facilities would enable the "metered flow" to continue easterly in a drainage ditch along Double Tree Ranch Road to the Indian Bend Wash.

However, depending on the level of protection at this location, the cross drainage structure could become fairly large and may require additional right-of-way along Double Tree Ranch Road to construct this structure. Since the outlet will be east of Tatum Boulevard, this will require a cooperative effort from the City of Phoenix and the Town of Paradise Valley.

For Sub-basins #400 and #410 within Drainage Area No. 2, the capacity of the retention basins between the "Tatum Foothills" subdivision and Tatum Boulevard may be reduced slightly by the proposed street widening in this location. This slight reduction in retention capacity may require a detention basin design with special consideration for discharging the "metered flow". Two alternative for handling the "metered flow" would be to: (1) discharge directly into a proposed trunkline down Tatum Boulevard; or (2) provide cross drainage structures beneath Tatum Boulevard to allow the flow to continue easterly.

For Drainage Area No. 3, the peak discharge at Tatum Boulevard would require an upgrading of the existing pipes to adequately convey the recommended storm event based on the level of protection. However, another alternative could be to construct a detention basin upstream of the existing culverts within the "Rancho Alta Vida" subdivision in order to reduce the peak discharge reaching Tatum Boulevard. The location under consideration is a common area within the subdivision that actually contains other such drainage facilities. No additional right-of-way needs to be obtained for this improvement.

Based on our preliminary drainage report, Kaminski-Hubbard Engineering, Inc. looks forward to the City of Phoenix comments and recommendations concerning the storm frequency required for the design of drainage facilities crossing Tatum Boulevard.

APPENDIX A

HYDROLOGIC DESIGN TABLES

```
8              .5300      .6030      .6330      .6600      .6840
8              .7050      .7240      .7420      .7590      .7750
8              .7900      .8043      .8180      .8312      .8439
8              .8561      .8678      .8790      .8898      .9002
8              .9103      .9201      .9297      .9391      .9483
8              .9573      .9661      .9747      .9832      .9916
8             1.0000     1.0000     1.0000     1.0000     1.0000
9 ENDTBL
```

```
    TABLE NO.      TIME INCREMENT
5 RAINFL 7                .0250

8              .0000      .0100      .0200      .0300      .0400
8              .0500      .0650      .0800      .1000      .1200
8              .1400      .1600      .1800      .2250      .3000
8              .4000      .5300      .6000      .6400      .6650
8              .7000      .7250      .7500      .7750      .8000
8              .8200      .8400      .8580      .8750      .8910
8              .9060      .9190      .9310      .9420      .9520
8              .9610      .9690      .9770      .9850      .9930
8             1.0000     1.0000     1.0000     1.0000     1.0000
9 ENDTBL
```

1 hour Rainfall Distribution Table

BASIC
>LOAD CN IN NEW
>RUN
14:45 11/03

CURVE NUMBER--STORM DURATION

1 HR	2 HR	3 HR	6 HR	12 HR	24 HR		240 HR
100.0	100.0	100.0	100.0	100.0	100.0		100.0
99.0	98.9	98.9	98.8	98.8	98.7		98.5
98.0	97.8	97.8	97.6	97.5	97.3		96.3
97.0	96.7	96.6	96.3	96.0	95.3		94.9
96.0	95.6	95.3	94.9	94.5	94.1		92.7
95.0	94.4	94.0	93.4	92.5	92.2		90.2
94.0	93.3	92.9	92.2	91.5	90.6		88.5
93.0	92.2	91.7	90.9	90.1	89.8		86.6
92.0	91.1	90.5	89.6	88.7	87.7		84.7
91.0	89.9	89.3	88.3	87.2	86.1		82.6
90.0	88.8	88.1	86.9	85.7	84.4		80.4
89.0	87.7	86.9	85.6	84.3	83.0	82.7	78.7
88.0	86.6	85.8	84.4	83.0	81.6	82.3	77.0
87.0	85.5	84.7	83.2	81.7	80.2	80.9	75.3
86.0	84.4	83.5	81.9	80.4	78.8	79.5	73.6
85.0	83.3	82.4	80.7	79.0	77.4	78.1	71.8
84.0	82.3	81.3	79.6	77.8	76.1		70.4
83.0	81.2	80.2	78.4	76.6	74.9		69.0
82.0	80.2	79.1	77.3	75.5	73.6		67.6
81.0	79.1	78.0	76.1	74.3	72.4		66.1
80.0	78.1	76.9	75.0	73.1	71.1	70.5	64.7
79.0	77.0	75.8	73.9	71.9	69.9		63.3
78.0	76.0	74.8	72.7	70.7	68.6		61.9
77.0	74.9	73.7	71.6	69.5	67.4		60.4
76.0	73.8	72.6	70.4	68.3	66.1		59.0
75.0	72.8	71.5	69.3	67.1	64.9		57.6
74.0	71.7	70.4	68.2	65.9	63.6		56.1
73.0	70.7	69.3	67.0	64.7	62.4		54.7
72.0	69.6	68.2	65.9	63.5	61.1		53.3
71.0	68.6	67.2	64.7	62.3	59.9		51.9
70.0	67.5	66.1	63.6	61.1	58.6		50.4
69.0	66.5	65.0	62.5	59.9	57.4		49.0
68.0	65.4	63.9	61.3	58.7	56.2		47.6
67.0	64.4	62.8	60.2	57.5	54.9		46.1
66.0	63.3	61.7	59.0	56.3	53.7		44.7
65.0	62.3	60.6	57.9	55.2	52.4		43.3
64.0	61.2	59.6	56.8	54.0	51.2		41.9
63.0	60.1	58.5	55.6	52.8	49.9		40.4

>BYE
11/03/70 14:49
RAD SPACE 0

Curve Number Reduction Table

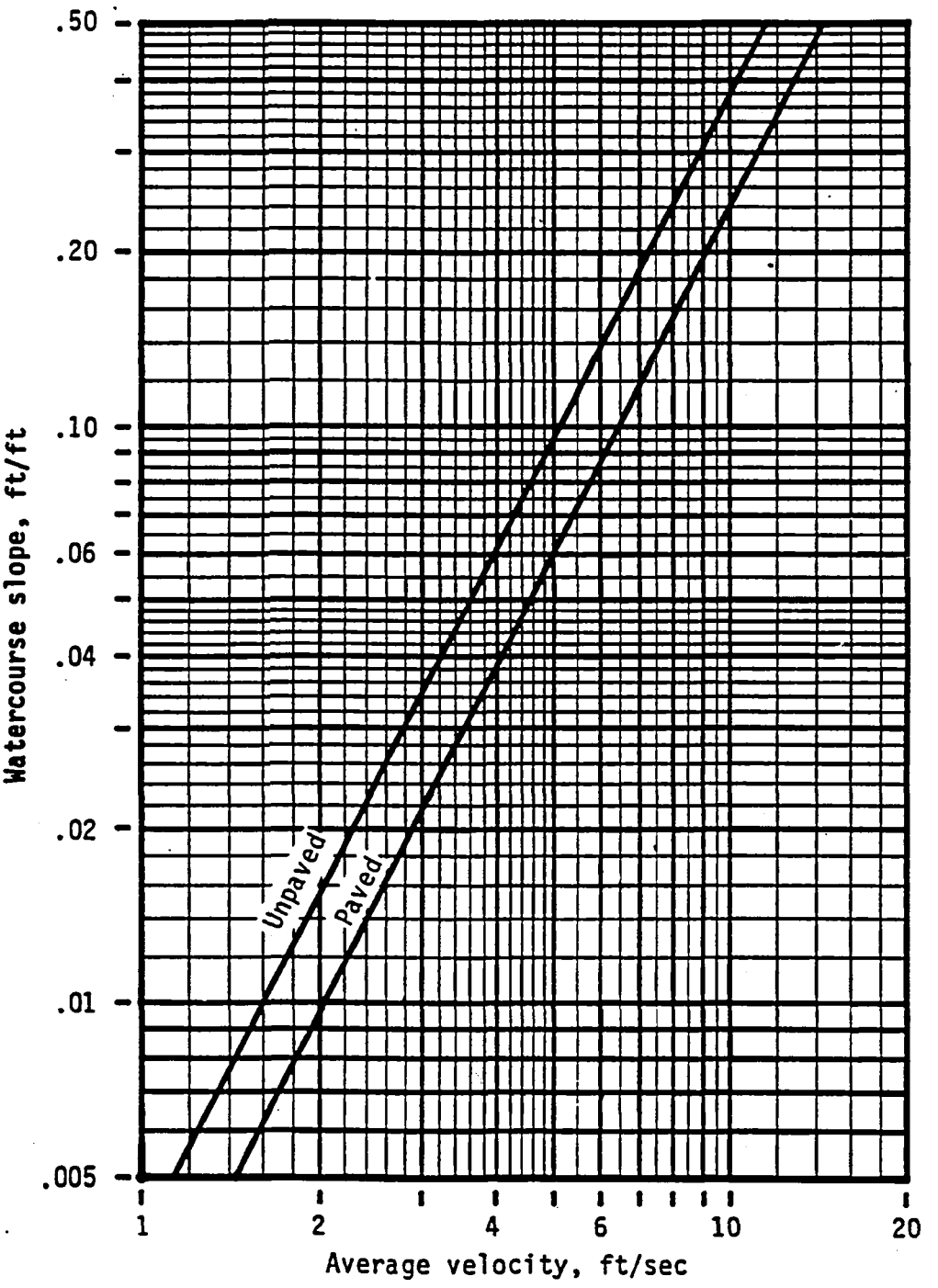

Figure 3-1.—Average velocities for estimating travel time for shallow concentrated flow.

Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overton and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007\,(nL)^{0.8}}{(P_2)^{0.5}\,s^{0.4}} \qquad \text{[Eq. 3-3]}$$

Table 3-1.—Roughness coefficients (Manning's n) for sheet flow

Surface description	n[1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses[2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

[1]The n values are a composite of information compiled by Engman (1986).
[2]Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
[3]When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

where

T_t = travel time (hr),
n = Manning's roughness coefficient (table 3-1),
L = flow length (ft),
P_2 = 2-year, 24-hour rainfall (in), and
s = slope of hydraulic grade line (land slope, ft/ft).

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bank-full elevation.

APPENDIX B-1

DRAINAGE AREA NO. 1

* HEC-1 OUTPUT

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID                 CITY OF PHOENIX PROJECT NO. P-886515
  2           ID               TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
  3           ID            KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 0118
  4           ID                    HEC-1 FILENAME :  118-19.DAT
  5           ID               PRELIMINARY RUN - 2 YEAR - 1 HOUR STORM .
  6           IT       5 07FEB90    1000     300 08FEB90    1000
  7           IO       5

  8           KK     100
  9           KM                     Subarea No. 100
 10           BA   .0852
 11           IN     1.5 07FEB90    1000
 12           PB     .88
 13           PC    .000    .010    .020    .030    .040    .050    .065    .080    .100
 14           PC    .120    .140    .160    .180    .225    .300    .400    .530    .600
 15           PC    .640    .665    .700    .725    .750    .775    .800    .820    .840
 16           PC    .858    .875    .891    .906    .919    .931    .942    .952    .961
 17           PC    .969    .977    .985    .993   1.000
 18           LS            95.0
 19           UD    .100

 20           KK    101R
 21           KM            Route Hydrograph 100 thru 101
 22           RL            .01
 23           RS      27    FLOW      -1     0.3
 24           RC    .030    .030    .030    1360    .072
 25           RX      10      15      22      29      31      38      45      50
 26           RY       6       5       4       3       3       4       5       6

 27           KK     101
 28           KM                     Subarea No. 101
 29           BA   .0789
 30           LS            95.0
 31           UD    .106

 32           KK    101C
 33           KM            Combine Hydrographs 100 & 101
 34           HC       2

 35           KK    104R
 36           KM            Route Hydrographs 100/101 thru 104
 37           RL            .15
 38           RS      41    FLOW      -1     0.3
 39           RC     .03     .03     .03    2060    .039
 40           RX      10      15      20      25      27      32      37      42
 41           RY       6       5       4       3       3       4       5       6

 42           KK     102
 43           KM            Subarea No. 102
 44           BA   .0358
 45           LS            92.0
 46           UD    .100
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 89           KK    302R
 90           KM            Route Hydrographs 100-104/200-201 thru 301
 91           RL            .08
 92           RS       5   FLOW      -1     0.3
 93           RC     .03   .018    .030     230    .030
 94           RX      10     12      14      34      82     102     104     106
 95           RY       8      7       7       2       2       7       7       8

 96           KK     300
 97           KM            Subarea No. 300
 98           BA   .0268
 99           LS           93.2
100           UD    .100

101           KK    301R
102           KM            Route Hydrograph 300 thru 301
103           RL           .0001
104           RK     720   .025    .015            TRAP       0      50

105           KK     301
106           KM            Subarea No. 301
107           BA   .0111
108           LS           86.0
109           UD    .131

110           KK    301C
111           KM            Combine Hydrographs 100-104/200-201 & 300-301
112           HC       3

113           KK    302R
114           KM            Route Hydrographs 100-104/200-201/300-301 thru 302
115           RL            .06
116           RS       6   FLOW      -1     0.3
117           RC     .03   .018     .03     370   .0148
118           RX      10     12      14      24      49      59      61      63
119           RY       6      7       7       2       2       7       7       8

120           KK     302
121           KM            Subarea No. 302
122           BA   .0174
123           LS           86.0
124           UD    .103

125           KK    302C
126           KM            Combine Hydrographs 100-104/200-201 & 300-302
127           HC       2

128           KK    303R
129           KM            Route Hydrographs 100-104/200-201 & 300-302 thru 303
130           RL            .03
131           RS      10   FLOW      -1     0.3
132           RC     .03   .018     .03     530   .0148
133           RX      10     12      14      24      49      59      61      63
134           RY       8      7       7       2       2       7       7       8
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 135          KK    304R
 136          KM            Route Hydrographs to 2 - 2' x 10' Culvert
 137          RL           .0001
 138          RS       5   FLOW      -1     0.3
 139          RC    .030   .022    .030     280   .0047
 140          RX      10     12      14      22     106     114     116     118
 141          RY       8      7       7       3       3       7       7       8

 142          KK     510
 143          KM            Subarea No. 510
 144          BA   .0271
 145          LS           86.0
 146          UD    .212

 147          KK    500R
 148          KM            Route Hydrograph 510 thru 500
 149          RL            .01
 150          RS      13   FLOW      -1     0.3
 151          RC    .025   .025    .025     650   .021
 152          RX      10     20      25      28      30      33      38      40
 153          RY       5      4       4       3       3       4       4       5

 154          KK     500
 155          KM            Subarea No. 500
 156          BA   .0402
 157          LS           86.0
 158          UD    .192

 159          KK    304C
 160          KM            Combine Hydrographs 100-104/200-201/300-302 & 500/510
 161          HC       3
 162          ZZ
```

```
*****************************************
*                                       *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1)    *
*            FEBRUARY 1981              *
*          REVISED 01 JUN 88            *
*                                       *
* RUN DATE  03/29/1990  TIME  08:04:43  *
*                                       *
*****************************************
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*****************************************
*                                       *
*    U.S. ARMY CORPS OF ENGINEERS       *
*  THE HYDROLOGIC ENGINEERING CENTER    *
*          609 SECOND STREET            *
*       DAVIS, CALIFORNIA 95616         *
*           (916) 551-1748              *
*                                       *
*****************************************
```

CITY OF PHOENIX PROJECT NO. P-886515
TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 0118
HEC-1 FILENAME : 118-19.DAT
PRELIMINARY RUN - 2 YEAR - 1 HOUR STORM

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

  IT         HYDROGRAPH TIME DATA
                   NMIN          5  MINUTES IN COMPUTATION INTERVAL
                  IDATE     7FEB90  STARTING DATE
                  ITIME       1000  STARTING TIME
                     NQ        289  NUMBER OF HYDROGRAPH ORDINATES
                 NDDATE     8FEB90  ENDING DATE
                 NDTIME       1000  ENDING TIME
                  ICENT         19  CENTURY MARK

            COMPUTATION INTERVAL     .08 HOURS
                 TOTAL TIME BASE   24.00 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	100	70.	.42	4.	1.	1.	.09		
ROUTED TO	101R	69.	.50	4.	1.	1.	.09	3.93	.50
HYDROGRAPH AT	101	63.	.42	4.	1.	1.	.08		
2 COMBINED AT	101C	124.	.42	8.	2.	2.	.16		
ROUTED TO	104R	122.	.50	7.	2.	2.	.16	4.52	.50
HYDROGRAPH AT	102	19.	.42	1.	0.	0.	.04		
ROUTED TO	104R	18.	.50	1.	0.	0.	.04		
HYDROGRAPH AT	103	25.	.42	2.	0.	0.	.03		
ROUTED TO	104R	22.	.50	2.	0.	0.	.03		
HYDROGRAPH AT	200	152.	.42	9.	2.	2.	.19		
ROUTED TO	201R	145.	.42	8.	2.	2.	.19		
HYDROGRAPH AT	201	4.	.50	0.	0.	0.	.02		
2 COMBINED AT	201C	148.	.42	8.	2.	2.	.21		
ROUTED TO	104R	136.	.50	8.	2.	2.	.21		
HYDROGRAPH AT	104	8.	.50	1.	0.	0.	.04		
5 COMBINED AT	104C	307.	.50	19.	5.	5.	.48		
ROUTED TO	302R	299.	.50	17.	4.	4.	.48	2.63	.50
HYDROGRAPH AT	300	17.	.42	1.	0.	0.	.03		
ROUTED TO	301R	15.	.50	1.	0.	0.	.03		
HYDROGRAPH AT	301	2.	.58	0.	0.	0.	.01		
3 COMBINED AT	301C	317.	.50	18.	5.	5.	.52		
ROUTED TO	302R	310.	.50	17.	4.	4.	.52	3.15	.50
HYDROGRAPH AT	302	4.	.50	0.	0.	0.	.02		
2 COMBINED AT	302C	314.	.50	18.	4.	4.	.54		
ROUTED TO	303R	307.	.50	17.	4.	4.	.54	3.13	.50
ROUTED TO	304R	281.	.50	17.	4.	4.	.54	3.82	.50
HYDROGRAPH AT	510	5.	.67	0.	0.	0.	.03		
ROUTED TO	500R	5.	.75	0.	0.	0.	.03	3.40	.75

HYDROGRAPH AT	500	7.	.07	1.	0.	0.	.04
3 COMBINED AT	3040	289.	.50	18.	5.	5.	.60

SUMMARY OF KINEMATIC WAVE ROUTING
(FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)

ISTAQ	ELEMENT	DT (MIN)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)	INTERPOLATED TO COMPUTATION INTERVAL DT (MIN)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)
104R	3	.86	18.64	27.60	.32	5.00	17.97	30.00	.31
CONTINUITY SUMMARY (AC-FT) - INFLOW=		.604	EXCESS=	.000	OUTFLOW=	.605	BASIN STORAGE=	.000	PERCENT ERROR= -.138
104R	3	.87	24.28	27.29	.41	5.00	22.48	30.00	.41
CONTINUITY SUMMARY (AC-FT) - INFLOW=		.758	EXCESS=	.000	OUTFLOW=	.756	BASIN STORAGE=	.000	PERCENT ERROR= .213
201R	3	.30	151.55	25.58	.39	5.00	144.71	25.00	.40
CONTINUITY SUMMARY (AC-FT) - INFLOW=		4.571	EXCESS=	.000	OUTFLOW=	3.914	BASIN STORAGE=	.000	PERCENT ERROR= 14.386
104R	3	.31	148.05	25.73	.37	5.00	136.37	30.00	.38
CONTINUITY SUMMARY (AC-FT) - INFLOW=		4.109	EXCESS=	.000	OUTFLOW=	4.107	BASIN STORAGE=	.000	PERCENT ERROR= .046
301R	3	.71	16.63	26.87	.37	5.00	15.44	30.00	.37
CONTINUITY SUMMARY (AC-FT) - INFLOW=		.526	EXCESS=	.000	OUTFLOW=	.525	BASIN STORAGE=	.000	PERCENT ERROR= .178

*** NORMAL END OF HEC-1 ***

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID                 CITY OF PHOENIX PROJECT NO. P-886515
  2           ID              TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
  3           ID           KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 0118
  4           ID                    HEC-1 FILENAME :  118-18.DAT
  5           ID              PRELIMINARY RUN - 10 YEAR - 1 HOUR STORM.
  6           IT       5 07FEB90    1000     300 08FEB90    1000
  7           IO       5

  8           KK     100
  9           KM                    Subarea No. 100
 10           BA   .0852
 11           IN     1.5 07FEB90    1000
 12           PB    1.61
 13           PC    .000    .010    .020    .030    .040    .050    .065    .080    .100
 14           PC    .120    .140    .160    .180    .225    .300    .400    .530    .600
 15           PC    .640    .665    .700    .725    .750    .775    .800    .820    .840
 16           PC    .858    .875    .891    .906    .919    .931    .942    .952    .961
 17           PC    .969    .977    .985    .993   1.000
 18           LS            95.0
 19           UD    .100

 20           KK    101R
 21           KM            Route Hydrograph 100 thru 101
 22           RL            .01
 23           RS      27    FLOW      -1     0.3
 24           RC     .03     .03     .03    1360    .072
 25           RX      10      12      22      32      34      44      54      56
 26           RY       8       7       5       3       3       5       7       8

 27           KK     101
 28           KM                    Subarea No. 101
 29           BA   .0789
 30           LS            95.0
 31           UD    .106

 32           KK    101C
 33           KM            Combine Hydrographs 100 & 101
 34           HC       2

 35           KK    104R
 36           KM            Route Hydrographs 100/101 thru 104
 37           RL            .045
 38           RS      41    FLOW      -1     0.3
 39           RC     .03     .03     .03    2060    .039
 40           RX      10      12      20      28      30      38      46      48
 41           RY       8       7       5       3       3       5       7       8

 42           KK     102
 43           KM            Subarea No. 102
 44           BA   .0358
 45           LS            92.0
 46           UD    .100
```

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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  47          KK    104R
  48          KM            Route Hydrograph 102 thru 104
  49          RL            .06
  50          RS     32    FLOW      -1     0.3
  51          RC    .03     .03     .03    1600    .044
  52          RX     10      12      22      32      34      44      54      56
  53          RY      8       7       5       3       3       5       7       8

  54          KK    103
  55          KM            Subarea No. 103
  56          BA   .0349
  57          LS           94.0
  58          UD    .100

  59          KK    104R
  60          KM            Route Hydrograph 103 thru 104
  61          RL           .0001
  62          RS     26    FLOW      -1     0.3
  63          RC    .03     .03     .03    1320    .064
  64          RX     10      12      22      32      34      44      54      56
  65          RY      8       7       5       3       3       5       7       8

  66          KK    200
  67          KM            Subarea No. 200
  68          BA   .1858
  69          LS           95.0
  70          UD    .100

  71          KK    201R
  72          KM            Route Hydrograph 200 thru 201
  73          RL           .001
  74          RK    640    .031    .030            TRAP       2       4

  75          KK    201
  76          KM            Subarea No. 201
  77          BA   .0211
  78          LS           86.0
  79          UD    .100

  80          KK    201C
  81          KM            Combine Hydrographs 200 & 201
  82          HC      2

  83          KK    104R
  84          KM            Route Hydrograph 200/201 thru 104
  85          RL          .0005
  86          RK    460    .022    .030            TRAP      10       9

  87          KK    104
  88          KM            Subarea No. 104
  89          BA   .0402
  90          LS           86.0
  91          UD    .100
```

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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  92          KK    104C
  93          KM            Combine Hydrographs 100-101/102/103/200-201 & 104
  94          HC       5

  95          KK    302R
  96          KM            Route Hydrographs 100-104/200-201 thru 301
  97          RL            .01
  98          RS       5   FLOW      -1     0.3
  99          RC     .03   .018    .030     230    .030
 100          RX      10     12      14      34      82     102     104     106
 101          RY       8      7       7       2       2       7       7       8

 102          KK     300
 103          KM            Subarea No. 300
 104          BA   .0268
 105          LS           93.2
 106          UD    .100

 107          KK    301R
 108          KM            Route Hydrograph 300 thru 301
 109          RL          .0001
 110          RK     720   .025    .015            TRAP       0      50

 111          KK     301
 112          KM            Subarea No. 301
 113          BA   .0111
 114          LS           86.0
 115          UD    .131

 116          KK    301C
 117          KM            Combine Hydrographs 100-104/200-201 & 300-301
 118          HC       3

 119          KK    302R
 120          KM            Route Hydrographs 100-104/200-201/300-301 thru 302
 121          RL            .02
 122          RS       8   FLOW      -1     0.3
 123          RC     .03   .018     .03     370   .0148
 124          RX      10     12      14      24      49      59      61      63
 125          RY       8      7       7       2       2       7       7       8

 126          KK     302
 127          KM            Subarea No. 302
 128          BA   .0174
 129          LS           86.0
 130          UD    .103

 131          KK    302C
 132          KM            Combine Hydrographs 100-104/200-201 & 300-302
 133          HC       2
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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 134          KK    303R
 135          KM            Route Hydrographs 100-104/200-201 & 300-302 thru 303
 136          RL            .05
 137          RS      10   FLOW      -1     0.3
 138          RC     .03   .018     .03     530   .0148
 139          RX      10     12      14      24      49      59      61      63
 140          RY       8      7       7       2       2       7       7       8

 141          KK    304R
 142          KM            Route Hydrographs to 2 - 2' x 10' Culvert
 143          RL           .075
 144          RS       5   FLOW      -1     0.3
 145          RC    .030   .022    .030     280   .0047
 146          RX      10     12      14      22     106     114     116     118
 147          RY       8      7       7       3       3       7       7       8

 148          KK     510
 149          KM            Subarea No. 510
 150          BA   .0271
 151          LS           86.0
 152          UD    .212

 153          KK    500R
 154          KM            Route Hydrograph 510 thru 500
 155          RL            .03
 156          RS      13   FLOW      -1     0.3
 157          RC    .025   .025    .025     650    .021
 158          RX      10     20      25      28      30      33      38      40
 159          RY       5      4       4       3       3       4       4       5

 160          KK     500
 161          KM            Subarea No. 500
 162          BA   .0402
 163          LS           86.0
 164          UD    .192

 165          KK    304C
 166          KM            Combine Hydrographs 100-104/200-201/300-302 & 500/510
 167          HC       3
 168          ZZ
```

```
****************************************
*                                      *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*            FEBRUARY 1981             *
*          REVISED 01 JUN 88           *
*                                      *
* RUN DATE  03/28/1990  TIME  16:36:17 *
*                                      *
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****************************************
*                                      *
*   U.S. ARMY CORPS OF ENGINEERS       *
* THE HYDROLOGIC ENGINEERING CENTER    *
*          609 SECOND STREET           *
*       DAVIS, CALIFORNIA 95616        *
*           (916) 551-1748             *
*                                      *
****************************************
```

CITY OF PHOENIX PROJECT NO. P-886515
TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 0118
HEC-1 FILENAME : 118-18.DAT
PRELIMINARY RUN - 10 YEAR - 1 HOUR STORM

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

  IT         HYDROGRAPH TIME DATA
                   NMIN          5  MINUTES IN COMPUTATION INTERVAL
                  IDATE     7FEB90  STARTING DATE
                  ITIME       1000  STARTING TIME
                     NQ        289  NUMBER OF HYDROGRAPH ORDINATES
                 NDDATE     8FEB90  ENDING DATE
                 NDTIME       1000  ENDING TIME
                  ICENT         19  CENTURY MARK

            COMPUTATION INTERVAL     .08 HOURS
                 TOTAL TIME BASE   24.00 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	100	173.	.42	10.	3.	3.	.09		
ROUTED TO	101R	170.	.42	10.	3.	3.	.09	4.51	.42
HYDROGRAPH AT	101	158.	.42	9.	2.	2.	.08		
2 COMBINED AT	101C	327.	.42	20.	5.	5.	.16		
ROUTED TO	104R	321.	.50	19.	5.	5.	.16	5.37	.50
HYDROGRAPH AT	102	57.	.42	3.	1.	1.	.04		
ROUTED TO	104R	56.	.50	3.	1.	1.	.04	4.07	.50
HYDROGRAPH AT	103	66.	.42	4.	1.	1.	.03		
ROUTED TO	104R	62.	.50	4.	1.	1.	.03	4.00	.42
HYDROGRAPH AT	200	378.	.42	22.	6.	6.	.19		
ROUTED TO	201R	367.	.42	22.	6.	6.	.19		
HYDROGRAPH AT	201	20.	.42	1.	0.	0.	.02		
2 COMBINED AT	201C	386.	.42	24.	6.	6.	.21		
ROUTED TO	104R	373.	.42	23.	6.	6.	.21		
HYDROGRAPH AT	104	37.	.42	2.	1.	1.	.04		
5 COMBINED AT	104C	802.	.50	51.	13.	13.	.48		
ROUTED TO	302R	784.	.50	51.	13.	13.	.48	3.06	.50
HYDROGRAPH AT	300	47.	.42	3.	1.	1.	.03		
ROUTED TO	301R	44.	.42	3.	1.	1.	.03		
HYDROGRAPH AT	301	10.	.50	1.	0.	0.	.01		
3 COMBINED AT	301C	833.	.50	54.	14.	14.	.52		
ROUTED TO	302R	821.	.50	53.	13.	13.	.52	4.00	.50
HYDROGRAPH AT	302	16.	.42	1.	0.	0.	.02		
2 COMBINED AT	302C	836.	.50	54.	14.	14.	.54		
ROUTED TO	303R	820.	.50	52.	13.	13.	.54	4.03	.50
ROUTED TO	304R	803.	.50	48.	12.	12.	.54	4.60	.50
HYDROGRAPH AT	510	19.	.58	2.	0.	0.	.03		
ROUTED TO	502R	19.	.67	2.	0.	0.	.03	3.30	.67

HYDROGRAPH AT	300	30.	.38	2.	1.	1.	.04
3 COMBINED AT	304C	845.	.50	52.	13.	13.	.60

SUMMARY OF KINEMATIC WAVE ROUTING
(FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)

ISTAQ	ELEMENT	DT (MIN)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)	INTERPOLATED TO COMPUTATION INTERVAL DT (MIN)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)
201R	3	.24	377.54	25.52	1.11	5.00	367.23	25.00	1.12

CONTINUITY SUMMARY (AC-FT) - INFLOW= 11.047 EXCESS= .000 OUTFLOW= 11.035 BASIN STORAGE= .000 PERCENT ERROR= .110

104R	3	.24	384.65	25.62	1.04	5.00	373.61	25.00	1.04

CONTINUITY SUMMARY (AC-FT) - INFLOW= 11.701 EXCESS= .000 OUTFLOW= 11.530 BASIN STORAGE= .000 PERCENT ERROR= 1.458

301R	3	.55	46.71	26.42	.98	5.00	43.75	25.00	.98

CONTINUITY SUMMARY (AC-FT) - INFLOW= 1.397 EXCESS= .000 OUTFLOW= 1.395 BASIN STORAGE= .000 PERCENT ERROR= .122

*** NORMAL END OF HEC-1 ***

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID                  CITY OF PHOENIX PROJECT NO. P-886515
  2           ID               TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
  3           ID            KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 0118
  4           ID                   HEC-1 FILENAME :  118-17.DAT
  5           ID               PRELIMINARY RUN - 25 YEAR - 1 HOUR STORM.
  6           IT       5 07FEB90    1000     300 08FEB90    1000
  7           IO       5

  8           KK     100
  9           KM                     Subarea No. 100
 10           BA   .0852
 11           IN     1.5 07FEB90    1000
 12           PB    2.02
 13           PC    .000    .010    .020    .030    .040    .050    .065    .080    .100
 14           PC    .120    .140    .160    .180    .225    .300    .400    .530    .600
 15           PC    .640    .665    .700    .725    .750    .775    .800    .820    .840
 16           PC    .858    .875    .891    .906    .919    .931    .942    .952    .961
 17           PC    .969    .977    .985    .993   1.000
 18           LS            95.0
 19           UD    .100

 20           KK    101R
 21           KM            Route Hydrograph 100 thru 101
 22           RL            .03
 23           RS      27    FLOW      -1     0.3
 24           RC     .03     .03     .03    1360    .072
 25           RX      10      12      22      32      34      44      54      56
 26           RY       8       7       5       3       3       5       7       8

 27           KK     101
 28           KM                     Subarea No. 101
 29           BA   .0789
 30           LS            95.0
 31           UD    .106

 32           KK    101C
 33           KM            Combine Hydrographs 100 & 101
 34           HC       2

 35           KK    104R
 36           KM            Route Hydrographs 100/101 thru 104
 37           RL           .0005
 38           RS      41    FLOW      -1     0.3
 39           RC     .03     .03     .03    2060    .039
 40           RX      10      12      20      28      30      38      46      48
 41           RY       8       7       5       3       3       5       7       8

 42           KK     102
 43           KM            Subarea No. 102
 44           BA   .0358
 45           LS            92.0
 46           UD    .100
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  47          KK    104R
  48          KM            Route Hydrograph 102 thru 104
  49          RL           .025
  50          RS     32    FLOW      -1     0.3
  51          RC    .03     .03     .03    1600    .044
  52          RX     10      12      22      32      34      44      54      56
  53          RY      8       7       5       3       3       5       7       8

  54          KK    103
  55          KM            Subarea No. 103
  56          BA   .0349
  57          LS           94.0
  58          UD    .100

  59          KK    104R
  60          KM            Route Hydrograph 103 thru 104
  61          RL          .0005
  62          RS     26    FLOW      -1     0.3
  63          RC    .03     .03     .03    1320    .064
  64          RX     10      12      22      32      34      44      54      56
  65          RY      8       7       5       3       3       5       7       8

  66          KK    200
  67          KM            Subarea No. 200
  68          BA   .1858
  69          LS           95.0
  70          UD    .100

  71          KK    201R
  72          KM            Route Hydrograph 200 thru 201
  73          RL           .001
  74          RK    640    .031    .030            TRAP       2       4

  75          KK    201
  76          KM            Subarea No. 201
  77          BA   .0211
  78          LS           86.0
  79          UD    .100

  80          KK    201C
  81          KM            Combine Hydrographs 200 & 201
  82          HC      2

  83          KK    104R
  84          KM            Route Hydrograph 200/201 thru 104
  85          RL           .001
  86          RK    460    .022    .030            TRAP      10       9

  87          KK    104
  88          KM            Subarea No. 104
  89          BA   .0402
  90          LS           86.0
  91          UD    .100
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  92          KK    104C
  93          KM            Combine Hydrographs 100-101/102/103/200-201 & 104
  94          HC       5

  95          KK    302R
  96          KM            Route Hydrographs 100-104/200-201 thru 301
  97          RL            .03
  98          RS       5   FLOW      -1     0.3
  99          RC     .03   .018    .030     230    .030
 100          RX      10     12      14      34      82     102     104     106
 101          RY       8      7       7       2       2       7       7       8

 102          KK     300
 103          KM            Subarea No. 300
 104          BA   .0268
 105          LS           93.2
 106          UD    .100

 107          KK    301R
 108          KM            Route Hydrograph 300 thru 301
 109          RL          .0005
 110          RK     720   .025    .015            TRAP       0      50

 111          KK     301
 112          KM            Subarea No. 301
 113          BA   .0111
 114          LS           86.0
 115          UD    .131

 116          KK    301C
 117          KM            Combine Hydrographs 100-104/200-201 & 300-301
 118          HC       3

 119          KK    302R
 120          KM            Route Hydrographs 100-104/200-201/300-301 thru 302
 121          RL            .02
 122          RS       8   FLOW      -1     0.3
 123          RC     .03   .018     .03     370   .0148
 124          RX      10     12      14      24      49      59      61      63
 125          RY       8      7       7       2       2       7       7       8

 126          KK     302
 127          KM            Subarea No. 302
 128          BA   .0174
 129          LS           86.0
 130          UD    .103

 131          KK    302C
 132          KM            Combine Hydrographs 100-104/200-201 & 300-302
 133          HC       2
```

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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 134          KK    303R
 135          KM            Route Hydrographs 100-104/200-201 & 300-302 thru 303
 136          RL           .005
 137          RS      10   FLOW      -1     0.3
 138          RC     .03   .018     .03     530   .0148
 139          RX      10     12      14      24      49      59      61      63
 140          RY       8      7       7       2       2       7       7       8

 141          KK    304R
 142          KM            Route Hydrographs to 2 - 2' x 10' Culvert
 143          RL           .05
 144          RS       5   FLOW      -1     0.3
 145          RC    .030   .022    .030     280   .0047
 146          RX      10     12      14      22     106     114     116     118
 147          RY       8      7       7       3       3       7       7       8

 148          KK     510
 149          KM            Subarea No. 510
 150          BA   .0271
 151          LS           86.0
 152          UD    .212

 153          KK    500R
 154          KM            Route Hydrograph 510 thru 500
 155          RL           .03
 156          RS      13   FLOW      -1     0.3
 157          RC    .025   .025    .025     650    .021
 158          RX      10     20      25      28      30      33      38      40
 159          RY       5      4       4       3       3       4       4       5

 160          KK     500
 161          KM            Subarea No. 500
 162          BA   .0402
 163          LS           86.0
 164          UD    .192

 165          KK    304C
 166          KM            Combine Hydrographs 100-104/200-201/300-302 & 500/510
 167          HC       3
 168          ZZ
```

```
*****************************************
*                                       *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1)    *
*            FEBRUARY 1981              *
*          REVISED 01 JUN 88            *
*                                       *
* RUN DATE  03/28/1990  TIME  15:54:25  *
*                                       *
*****************************************
```

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*****************************************
*                                       *
*    U.S. ARMY CORPS OF ENGINEERS       *
*  THE HYDROLOGIC ENGINEERING CENTER    *
*          609 SECOND STREET            *
*       DAVIS, CALIFORNIA 95616         *
*           (916) 551-1748              *
*                                       *
*****************************************
```

CITY OF PHOENIX PROJECT NO. P-886515
TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 0118
HEC-1 FILENAME : 118-17.DAT
PRELIMINARY RUN - 25 YEAR - 1 HOUR STORM

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

   IT         HYDROGRAPH TIME DATA
                    NMIN          5  MINUTES IN COMPUTATION INTERVAL
                   IDATE     7FEB90  STARTING DATE
                   ITIME       1000  STARTING TIME
                      NQ        289  NUMBER OF HYDROGRAPH ORDINATES
                  NDDATE     8FEB90  ENDING DATE
                  NDTIME       1000  ENDING TIME
                   ICENT         19  CENTURY MARK

             COMPUTATION INTERVAL     .08 HOURS
                  TOTAL TIME BASE   24.00 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	100	234.	.42	14.	3.	3.	.09		
ROUTED TO	101R	227.	.42	13.	3.	3.	.09	4.72	.42
HYDROGRAPH AT	101	213.	.42	13.	3.	3.	.08		
2 COMBINED AT	101C	440.	.42	26.	7.	7.	.16		
ROUTED TO	104R	430.	.50	26.	7.	7.	.16	5.60	.50
HYDROGRAPH AT	102	81.	.42	5.	1.	1.	.04		
ROUTED TO	104R	80.	.50	5.	1.	1.	.04	4.22	.50
HYDROGRAPH AT	103	90.	.42	5.	1.	1.	.03		
ROUTED TO	104R	88.	.42	5.	1.	1.	.03	4.16	.42
HYDROGRAPH AT	200	510.	.42	30.	8.	8.	.19		
ROUTED TO	201R	498.	.42	30.	7.	7.	.19		
HYDROGRAPH AT	201	31.	.42	2.	0.	0.	.02		
2 COMBINED AT	201C	529.	.42	32.	8.	8.	.21		
ROUTED TO	104R	513.	.42	31.	8.	8.	.21		
HYDROGRAPH AT	104	59.	.42	4.	1.	1.	.04		
5 COMBINED AT	104C	1128.	.42	71.	18.	18.	.48		
ROUTED TO	302R	1108.	.42	69.	17.	17.	.48	3.32	.42
HYDROGRAPH AT	300	66.	.42	4.	1.	1.	.03		
ROUTED TO	301R	62.	.42	4.	1.	1.	.03		
HYDROGRAPH AT	301	15.	.50	1.	0.	0.	.01		
3 COMBINED AT	301C	1183.	.42	74.	18.	18.	.52		
ROUTED TO	302R	1160.	.42	72.	18.	18.	.52	4.44	.42
HYDROGRAPH AT	302	25.	.42	2.	0.	0.	.02		
2 COMBINED AT	302C	1185.	.42	74.	18.	18.	.54		
ROUTED TO	303R	1154.	.42	74.	18.	18.	.54	4.42	.42
ROUTED TO	304R	1139.	.50	70.	18.	18.	.54	4.94	.50
HYDROGRAPH AT	510	30.	.58	3.	1.	1.	.03		
ROUTED TO	502R	28.	.58	2.	1.	1.	.23	3.97	.58

HYDROGRAPH AT	500	46.	.58	4.	1.	1.	.04
3 COMBINED AT	304C	1207.	.50	76.	19.	19.	.60

SUMMARY OF KINEMATIC WAVE ROUTING
(FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)

ISTAQ	ELEMENT	DT	PEAK	TIME TO PEAK	VOLUME	INTERPOLATED TO COMPUTATION INTERVAL DT	PEAK	TIME TO PEAK	VOLUME
		(MIN)	(CFS)	(MIN)	(IN)	(MIN)	(CFS)	(MIN)	(IN)
201R	3	.22	509.06	25.51	1.50	5.00	498.05	25.00	1.50

CONTINUITY SUMMARY (AC-FT) - INFLOW= 14.883 EXCESS= .000 OUTFLOW= 14.852 BASIN STORAGE= .000 PERCENT ERROR= .208

104R	3	.22	528.72	25.44	1.41	5.00	513.91	25.00	1.39

CONTINUITY SUMMARY (AC-FT) - INFLOW= 15.847 EXCESS= .000 OUTFLOW= 15.547 BASIN STORAGE= .000 PERCENT ERROR= 1.895

301R	3	.50	65.75	25.98	1.35	5.00	61.72	25.00	1.36

CONTINUITY SUMMARY (AC-FT) - INFLOW= 1.928 EXCESS= .000 OUTFLOW= 1.929 BASIN STORAGE= .000 PERCENT ERROR= -.059

*** NORMAL END OF HEC-1 ***

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID                 CITY OF PHOENIX PROJECT NO. P-886515
  2           ID              TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
  3           ID           KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 0118
  4           ID                     HEC-1 FILENAME :  118-16.DAT
  5           ID              PRELIMINARY RUN - 50 YEAR - 1 HOUR STORM.
  6           IT       5 07FEB90    1000     300 08FEB90    1000
  7           IO       5

  8           KK     100
  9           KM                     Subarea No. 100
 10           BA   .0852
 11           IN     1.5 07FEB90    1000
 12           PB    2.35
 13           PC    .000    .010    .020    .030    .040    .050    .065    .080    .100
 14           PC    .120    .140    .160    .180    .225    .300    .400    .530    .600
 15           PC    .640    .665    .700    .725    .750    .775    .800    .820    .840
 16           PC    .858    .875    .891    .906    .919    .931    .942    .952    .961
 17           PC    .969    .977    .985    .993   1.000
 18           LS            95.0
 19           UD    .100

 20           KK    101R
 21           KM            Route Hydrograph 100 thru 101
 22           RL            .03
 23           RS      27    FLOW      -1     0.3
 24           RC     .03     .03     .03    1360    .072
 25           RX      10      12      22      32      34      44      54      56
 26           RY       8       7       5       3       3       5       7       8

 27           KK     101
 28           KM                     Subarea No. 101
 29           BA   .0789
 30           LS            95.0
 31           UD    .106

 32           KK    101C
 33           KM            Combine Hydrographs 100 & 101
 34           HC       2

 35           KK    104R
 36           KM            Route Hydrographs 100/101 thru 104
 37           RL           .0005
 38           RS      41    FLOW      -1     0.3
 39           RC     .03     .03     .03    2060    .039
 40           RX      10      12      20      28      30      38      46      48
 41           RY       8       7       5       3       3       5       7       8

 42           KK     102
 43           KM            Subarea No. 102
 44           BA   .0358
 45           LS            92.0
 46           UD    .100
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 47           KK    104R
 48           KM            Route Hydrograph 102 thru 104
 49           RL            .01
 50           RS      32   FLOW      -1     0.3
 51           RC     .03    .03     .03    1600    .044
 52           RX      10     12      22      32      34      44      54      56
 53           RY       8      7       5       3       3       5       7       8

 54           KK     103
 55           KM            Subarea No. 103
 56           BA   .0349
 57           LS           94.0
 58           UD    .100

 59           KK    104R
 60           KM            Route Hydrograph 103 thru 104
 61           RL          .0005
 62           RS      26   FLOW      -1     0.3
 63           RC     .03    .03     .03    1320    .064
 64           RX      10     12      22      32      34      44      54      56
 65           RY       8      7       5       3       3       5       7       8
 66           RK    1320   .064    .030            TRAP       2       7

 67           KK     200
 68           KM            Subarea No. 200
 69           BA   .1858
 70           LS           95.0
 71           UD    .100

 72           KK    201R
 73           KM            Route Hydrograph 200 thru 201
 74           RL           .001
 75           RK     640   .031    .030            TRAP       2       4

 76           KK     201
 77           KM            Subarea No. 201
 78           BA   .0211
 79           LS           86.0
 80           UD    .100

 81           KK    201C
 82           KM            Combine Hydrographs 200 & 201
 83           HC       2

 84           KK    104R
 85           KM            Route Hydrograph 200/201 thru 104
 86           RL           .001
 87           RK     460   .022    .030            TRAP      10       9
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 88           KK     104
 89           KM            Subarea No. 104
 90           BA   .0402
 91           LS           86.0
 92           UD    .100

 93           KK    104C
 94           KM            Combine Hydrographs 100-101/102/103/200-201 & 104
 95           HC       5

 96           KK    302R
 97           KM            Route Hydrographs 100-104/200-201 thru 301
 98           RL            .01
 99           RS       5   FLOW      -1     0.3
100           RC     .03   .018    .030     230    .030
101           RX      10     12      14      34      82     102     104     106
102           RY       8      7       7       2       2       7       7       8

103           KK     300
104           KM            Subarea No. 300
105           BA   .0268
106           LS           93.2
107           UD    .100

108           KK    301R
109           KM            Route Hydrograph 300 thru 301
110           RL          .0001
111           RK     720   .025    .015            TRAP       0      50

112           KK     301
113           KM            Subarea No. 301
114           BA   .0111
115           LS           86.0
116           UD    .131

117           KK    301C
118           KM            Combine Hydrographs 100-104/200-201 & 300-301
119           HC       3

120           KK    302R
121           KM            Route Hydrographs 100-104/200-201/300-301 thru 302
122           RL            .01
123           RS       8   FLOW      -1     0.3
124           RC     .03   .018     .03     370   .0148
125           RX      10     12      14      24      49      59      61      63
126           RY       8      7       7       2       2       7       7       8

127           KK     302
128           KM            Subarea No. 302
129           BA   .0174
130           LS           86.0
131           UD    .103
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 132          KK    302C
 133          KM            Combine Hydrographs 100-104/200-201 & 300-302
 134          HC       2

 135          KK    303R
 136          KM            Route Hydrographs 100-104/200-201 & 300-302 thru 303
 137          RL            .01
 138          RS      10   FLOW      -1     0.3
 139          RC     .03   .018     .03     530   .0148
 140          RX      10     12      14      24      49      59      61      63
 141          RY       8      7       7       2       2       7       7       8

 142          KK    304R
 143          KM            Route Hydrographs to 2 - 2' x 10' Culvert
 144          RL            .03
 145          RS       5   FLOW      -1     0.3
 146          RC    .030   .022    .030     280   .0047
 147          RX      10     12      14      22     106     114     116     118
 148          RY       8      7       7       3       3       7       7       8

 149          KK     510
 150          KM            Subarea No. 510
 151          BA   .0271
 152          LS          86.0
 153          UD    .212

 154          KK    500R
 155          KM            Route Hydrograph 510 thru 500
 156          RL            .03
 157          RS      13   FLOW      -1     0.3
 158          RC    .025   .025    .025     650    .021
 159          RX      10     20      25      28      30      33      38      40
 160          RY       5      4       4       3       3       4       4       5

 161          KK     500
 162          KM            Subarea No. 500
 163          BA   .0402
 164          LS          86.0
 165          UD    .192

 166          KK    304C
 167          KM            Combine Hydrographs 100-104/200-201/300-302 & 500/510
 168          HC       3
 169          ZZ
```

```
****************************************
*                                      *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*            FEBRUARY 1981             *
*          REVISED 01 JUN 88           *
*                                      *
* RUN DATE  03/28/1990  TIME  15:06:43 *
*                                      *
****************************************
```

```
****************************************
*                                      *
*   U.S. ARMY CORPS OF ENGINEERS       *
* THE HYDROLOGIC ENGINEERING CENTER    *
*         609 SECOND STREET            *
*      DAVIS, CALIFORNIA 95616         *
*          (916) 551-1748              *
*                                      *
****************************************
```

CITY OF PHOENIX PROJECT NO. P-886515
TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 0118
HEC-1 FILENAME : 118-16.DAT
PRELIMINARY RUN - 50 YEAR - 1 HOUR STORM

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

   IT         HYDROGRAPH TIME DATA
                    NMIN          5  MINUTES IN COMPUTATION INTERVAL
                   IDATE     7FEB90  STARTING DATE
                   ITIME       1000  STARTING TIME
                      NQ        289  NUMBER OF HYDROGRAPH ORDINATES
                  NDDATE     8FEB90  ENDING DATE
                  NDTIME       1000  ENDING TIME
                   ICENT         19  CENTURY MARK

             COMPUTATION INTERVAL     .08 HOURS
                  TOTAL TIME BASE   24.00 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	100	283.	.42	17.	4.	4.	.09		
ROUTED TO	101R	276.	.42	16.	4.	4.	.09	4.87	.42
HYDROGRAPH AT	101	258.	.42	15.	4.	4.	.08		
2 COMBINED AT	101C	534.	.42	32.	8.	8.	.16		
ROUTED TO	104R	509.	.50	32.	8.	8.	.16	5.76	.50
HYDROGRAPH AT	102	101.	.42	6.	1.	1.	.04		
ROUTED TO	104R	99.	.50	6.	1.	1.	.04	4.34	.50
HYDROGRAPH AT	103	110.	.42	6.	2.	2.	.03		
ROUTED TO	104R	103.	.42	7.	2.	2.	.03		
HYDROGRAPH AT	200	618.	.42	36.	9.	9.	.19		
ROUTED TO	201R	604.	.42	36.	9.	9.	.19		
HYDROGRAPH AT	201	41.	.42	3.	1.	1.	.02		
2 COMBINED AT	201C	645.	.42	39.	10.	10.	.21		
ROUTED TO	104R	628.	.42	39.	10.	10.	.21		
HYDROGRAPH AT	104	79.	.42	5.	1.	1.	.04		
5 COMBINED AT	104C	1398.	.42	88.	22.	22.	.48		
ROUTED TO	302R	1368.	.42	87.	22.	22.	.48	3.48	.42
HYDROGRAPH AT	300	81.	.42	5.	1.	1.	.03		
ROUTED TO	301R	77.	.42	5.	1.	1.	.03		
HYDROGRAPH AT	301	19.	.50	1.	0.	0.	.01		
3 COMBINED AT	301C	1463.	.42	93.	23.	23.	.52		
ROUTED TO	302R	1427.	.42	92.	23.	23.	.52	4.74	.42
HYDROGRAPH AT	302	34.	.42	2.	1.	1.	.02		
2 COMBINED AT	302C	1460.	.42	94.	24.	24.	.54		
ROUTED TO	303R	1440.	.50	93.	23.	23.	.54	4.75	.50
ROUTED TO	304R	1414.	.50	91.	23.	23.	.54	5.19	.50
HYDROGRAPH AT	510	39.	.58	3.	1.	1.	.03		
ROUTED TO	500R	37.	.58	3.	1.	1.	.03	4.23	.58

HYDROGRAPH AT	500	60.	.58	5.	1.	1.	.04
3 COMBINED AT	304C	1503.	.50	99.	25.	25.	.60

SUMMARY OF KINEMATIC WAVE ROUTING
(FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)

ISTAQ	ELEMENT	DT (MIN)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)	INTERPOLATED TO COMPUTATION INTERVAL DT (MIN)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)
104R	3	.59	109.41	26.06	1.73	5.00	102.94	25.00	1.73

CONTINUITY SUMMARY (AC-FT) - INFLOW= 3.214 EXCESS= .000 OUTFLOW= 3.211 BASIN STORAGE= .000 PERCENT ERROR= .076

201R	3	.21	616.11	25.37	1.82	5.00	604.34	25.00	1.83

CONTINUITY SUMMARY (AC-FT) - INFLOW= 18.019 EXCESS= .000 OUTFLOW= 18.019 BASIN STORAGE= .000 PERCENT ERROR= -.001

104R	3	.21	644.69	25.44	1.75	5.00	628.88	25.00	1.75

CONTINUITY SUMMARY (AC-FT) - INFLOW= 19.338 EXCESS= .000 OUTFLOW= 19.301 BASIN STORAGE= .000 PERCENT ERROR= .189

301R	3	.48	80.57	26.09	1.66	5.00	76.54	25.00	1.66

CONTINUITY SUMMARY (AC-FT) - INFLOW= 2.367 EXCESS= .000 OUTFLOW= 2.366 BASIN STORAGE= .000 PERCENT ERROR= .038

*** NORMAL END OF HEC-1 ***

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID                 CITY OF PHOENIX PROJECT NO. P-886515
  2           ID              TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
  3           ID           KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 0118
  4           ID                     HEC-1 FILENAME :  118-15.DAT
  5           ID              PRELIMINARY RUN - 100 YEAR - 1 HOUR STORM
  6           IT       5 07FEB90    1000     300 08FEB90    1000
  7           IO       5

  8           KK     100
  9           KM                     Subarea No. 100
 10           BA   .0852
 11           IN     1.5 07FEB90    1000
 12           PB    2.66
 13           PC    .000    .010    .020    .030    .040    .050    .065    .080    .100
 14           PC    .120    .140    .160    .180    .225    .300    .400    .530    .600
 15           PC    .640    .665    .700    .725    .750    .775    .800    .820    .840
 16           PC    .858    .875    .891    .906    .919    .931    .942    .952    .961
 17           PC    .969    .977    .985    .993   1.000
 18           LS           95.0
 19           UD    .100

 20           KK    101R
 21           KM            Route Hydrograph 100 thru 101
 22           RL            .03
 23           RS      27    FLOW      -1     0.3
 24           RC     .03     .03     .03    1360    .072
 25           RX      10      12      22      32      34      44      54      56
 26           RY       8       7       5       3       3       5       7       8

 27           KK     101
 28           KM                   Subarea No. 101
 29           BA   .0789
 30           LS           95.0
 31           UD    .106

 32           KK    101C
 33           KM            Combine Hydrographs 100 & 101
 34           HC       2

 35           KK    104R
 36           KM            Route Hydrographs 100/101 thru 104
 37           RL           .001
 38           RS      41    FLOW      -1     0.3
 39           RC     .03     .03     .03    2060    .039
 40           RX      10      12      20      28      30      38      46      48
 41           RY       8       7       5       3       3       5       7       8

 42           KK     102
 43           KM            Subarea No. 102
 44           BA   .0358
 45           LS           92.0
 46           UD    .100
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 47           KK    104R
 48           KM            Route Hydrograph 102 thru 104
 49           RL           .001
 50           RS     32   FLOW      -1     0.3
 51           RC    .03    .03     .03    1600    .044
 52           RX     10     12      22      32      34      44      54      56
 53           RY      8      7       5       3       3       5       7       8

 54           KK    103
 55           KM            Subarea No. 103
 56           BA  .0349
 57           LS           94.0
 58           UD   .100

 59           KK    104R
 60           KM            Route Hydrograph 103 thru 104
 61           RL           .015
 62           RS     26   FLOW      -1     0.3
 63           RC    .03    .03     .03    1320    .064
 64           RX     10     12      22      32      34      44      54      56
 65           RY      8      7       5       3       3       5       7       8

 66           KK    200
 67           KM            Subarea No. 200
 68           BA  .1858
 69           LS           95.0
 70           UD   .100

 71           KK    201R
 72           KM            Route Hydrograph 200 thru 201
 73           RL            .001
 74           RK    640   .031    .030            TRAP      2       4

 75           KK    201
 76           KM            Subarea No. 201
 77           BA  .0211
 78           LS           86.0
 79           UD   .100

 80           KK    201C
 81           KM            Combine Hydrographs 200 & 201
 82           HC      2

 83           KK    104R
 84           KM            Route Hydrograph 200/201 thru 104
 85           RL           .001
 86           RK    460   .022    .030            TRAP     10       9

 87           KK    104
 88           KM            Subarea No. 104
 89           BA  .0402
 90           LS           86.0
 91           UD   .100
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  92          KK    104C
  93          KM            Combine Hydrographs 100-101/102/103/200-201 & 104
  94          HC       5

  95          KK    302R
  96          KM            Route Hydrographs 100-104/200-201 thru 301
  97          RL           .015
  98          RS       5   FLOW      -1     0.3
  99          RC     .03   .018    .030     230    .030
 100          RX      10     12      14      34      82     102     104     106
 101          RY       8      7       7       2       2       7       7       8

 102          KK     300
 103          KM            Subarea No. 300
 104          BA   .0268
 105          LS           93.2
 106          UD    .100

 107          KK    301R
 108          KM            Route Hydrograph 300 thru 301
 109          RL          .0005
 110          RK     720   .025    .015            TRAP       0      50

 111          KK     301
 112          KM            Subarea No. 301
 113          BA   .0111
 114          LS           86.0
 115          UD    .131

 116          KK    301C
 117          KM            Combine Hydrographs 100-104/200-201 & 300-301
 118          HC       3

 119          KK    302R
 120          KM            Route Hydrographs 100-104/200-201/300-301 thru 302
 121          RL           .015
 122          RS       8   FLOW      -1     0.3
 123          RC     .03   .018     .03     370   .0148
 124          RX      10     12      14      24      49      59      61      63
 125          RY       8      7       7       2       2       7       7       8

 126          KK     302
 127          KM            Subarea No. 302
 128          BA   .0174
 129          LS           86.0
 130          UD    .103

 131          KK    302C
 132          KM            Combine Hydrographs 100-104/200-201 & 300-302
 133          HC       2
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 134          KK    303R
 135          KM            Route Hydrographs 100-104/200-201 & 300-302 thru 303
 136          RL            .01
 137          RS     10    FLOW      -1     0.3
 138          RC    .03    .018     .03     530   .0148
 139          RX     10      12      14      24      49      59      61      63
 140          RY      8       7       7       2       2       7       7       8

 141          KK    304R
 142          KM            Route Hydrographs to 2 - 2' x 10' Culvert
 143          RL            .03
 144          RS      5    FLOW      -1     0.3
 145          RC   .030    .022    .030     280   .0047
 146          RX     10      12      14      22     106     114     116     118
 147          RY      8       7       7       3       3       7       7       8

 148          KK    510
 149          KM            Subarea No. 510
 150          BA  .0271
 151          LS           86.0
 152          UD   .212

 153          KK    500R
 154          KM            Route Hydrograph 510 thru 500
 155          RL            .04
 156          RS     13    FLOW      -1     0.3
 157          RC   .025    .025    .025     650    .021
 158          RX     10      20      25      28      30      33      38      40
 159          RY      5       4       4       3       3       4       4       5

 160          KK    500
 161          KM            Subarea No. 500
 162          BA  .0402
 163          LS           86.0
 164          UD   .192

 165          KK    304C
 166          KM            Combine Hydrographs 100-104/200-201/300-302 & 500/510
 167          HC      3
 168          ZZ
```

```
**************************************
*                                    *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1) *
*            FEBRUARY 1981           *
*          REVISED 01 JUN 88         *
*                                    *
* RUN DATE  03/28/1990  TIME  14:26:42 *
*                                    *
**************************************
```

```
**************************************
*                                    *
*   U.S. ARMY CORPS OF ENGINEERS     *
* THE HYDROLOGIC ENGINEERING CENTER  *
*         609 SECOND STREET          *
*      DAVIS, CALIFORNIA 95616       *
*          (916) 551-1748            *
*                                    *
**************************************
```

CITY OF PHOENIX PROJECT NO. P-886515
TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 0118
HEC-1 FILENAME : 118-15.DAT
PRELIMINARY RUN - 100 YEAR - 1 HOUR STORM

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

   IT         HYDROGRAPH TIME DATA
                    NMIN          5  MINUTES IN COMPUTATION INTERVAL
                   IDATE     7FEB90  STARTING DATE
                   ITIME       1000  STARTING TIME
                      NQ        289  NUMBER OF HYDROGRAPH ORDINATES
                  NDDATE     8FEB90  ENDING DATE
                  NDTIME       1000  ENDING TIME
                   ICENT         19  CENTURY MARK

             COMPUTATION INTERVAL     .08 HOURS
                  TOTAL TIME BASE   24.00 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	100	330.	.42	19.	5.	5.	.09		
ROUTED TO	101R	324.	.42	19.	5.	5.	.09	4.98	.42
HYDROGRAPH AT	101	301.	.42	18.	4.	4.	.08		
2 COMBINED AT	101C	625.	.42	37.	9.	9.	.16		
ROUTED TO	104R	568.	.42	37.	9.	9.	.16	5.93	.42
HYDROGRAPH AT	102	120.	.42	7.	2.	2.	.04		
ROUTED TO	104R	116.	.50	7.	2.	2.	.04	4.42	.50
HYDROGRAPH AT	103	129.	.42	8.	2.	2.	.03		
ROUTED TO	104R	126.	.42	7.	2.	2.	.03	4.37	.42
HYDROGRAPH AT	200	719.	.42	42.	11.	11.	.19		
ROUTED TO	201R	704.	.42	42.	11.	11.	.19		
HYDROGRAPH AT	201	51.	.42	3.	1.	1.	.02		
2 COMBINED AT	201C	756.	.42	46.	11.	11.	.21		
ROUTED TO	104R	738.	.42	46.	11.	11.	.21		
HYDROGRAPH AT	104	98.	.42	6.	1.	1.	.04		
5 COMBINED AT	104C	1660.	.42	103.	26.	26.	.48		
ROUTED TO	302R	1619.	.42	101.	25.	25.	.48	3.64	.42
HYDROGRAPH AT	300	96.	.42	6.	1.	1.	.03		
ROUTED TO	301R	91.	.42	6.	1.	1.	.03		
HYDROGRAPH AT	301	24.	.50	2.	0.	0.	.01		
3 COMBINED AT	301C	1732.	.42	109.	27.	27.	.52		
ROUTED TO	302R	1682.	.42	107.	27.	27.	.52	5.02	.42
HYDROGRAPH AT	302	42.	.42	3.	1.	1.	.02		
2 COMBINED AT	302C	1724.	.42	110.	27.	27.	.54		
ROUTED TO	303R	1682.	.42	108.	27.	27.	.54	5.01	.42
ROUTED TO	304R	1639.	.50	105.	26.	26.	.54	5.39	.50
HYDROGRAPH AT	510	48.	.58	4.	1.	1.	.03		
ROUTED TO	500R	46.	.59	4.	1.	1.	.03	4.15	.59

HYDROGRAPH AT	500	73.	.58	6.	1.	1.	.04
3 COMBINED AT	304C	1749.	.50	115.	29.	29.	.60

SUMMARY OF KINEMATIC WAVE ROUTING
(FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)

ISTAQ	ELEMENT	DT (MIN)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)	INTERPOLATED TO COMPUTATION INTERVAL DT (MIN)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)
201R	3	.21	715.89	25.33	2.12	5.00	704.50	25.00	2.13

CONTINUITY SUMMARY (AC-FT) - INFLOW= 20.991 EXCESS= .000 OUTFLOW= 20.992 BASIN STORAGE= .000 PERCENT ERROR= -.005

104R	3	.20	755.02	25.43	2.05	5.00	738.46	25.00	2.05

CONTINUITY SUMMARY (AC-FT) - INFLOW= 22.621 EXCESS= .000 OUTFLOW= 22.566 BASIN STORAGE= .000 PERCENT ERROR= .243

301R	3	.46	95.41	25.89	1.95	5.00	90.65	25.00	1.96

CONTINUITY SUMMARY (AC-FT) - INFLOW= 2.785 EXCESS= .000 OUTFLOW= 2.782 BASIN STORAGE= .000 PERCENT ERROR= .115

*** NORMAL END OF HEC-1 ***

APPENDIX B-2

DRAINAGE AREA NO. 1

* DESIGN CALCULATIONS

KAMINSKI HUBBARD engineering inc. • Surveying • Civil • Hydrology	Made by D.L.B	Date 2-16-90	Job No. 011B
	Checked by	Date	Sheet No.
	For		

SUBBASIN No. 100

Drainage Area = 0.08515 mi.^{2} = 54.49 Ac.

Zoning : Hillside (over 10% sloping)
Type D CN (1hr.) = ~~98~~ 95
CN (24hr.) = ~~97.3~~ 92.2

'C' Coefficient = 0.70

SUBBASIN No. 101

Drainage Area = 0.07885 mi.^{2} = 50.46 Ac.

Zoning : Hillside (over 10% Sloping)
Type D CN (1hr.) = ~~98~~ 95
CN (24 hr.) = ~~97.3~~ 92.2

'C' Coefficient = 0.70

SUBBASIN No. 102

Total Drainage Area = 0.03709 mi.^{2} = 23.74 Ac.

a. Zoning : RE-43 CN (1hr.) = 86 C = 0.45
Drainage Area = 0.0132 mi.^{2} = 8.45 Ac.
Assume 90% Contributes
∴ Drainage Area = 0.01188 mi.^{2} = 7.60 Ac.

b. Zoning : Hillside (over 10% Sloping) CN (1hr.) = ~~98~~ 95
Drainage Area = 0.02397 mi.^{2} = 15.29 Ac.
C = 0.70

Weighted Curve No.

$$CN\ (1hr.) = \frac{(86)(0.01188) + (\cancel{98}\ 95)(0.02397)}{0.03577} = \cancel{94.9}\ 92.0$$

CN (24hr.) = ~~92.6~~ 87.7

Weighted 'C' Coefficient:

$$C = \frac{(0.45)(0.01188) + (0.70)(0.02397)}{0.03577} = 0.62$$

Total Contributing Drainage Area = 0.03577 mi.^{2} = 22.89 Ac.

KAMINSKI HUBBARD engineering inc. • Surveying • Civil • Hydrology	Made by D.L.B.	Date 2-16-90	Job No. 0118
	Checked by	Date	Sheet No.
	For		

SUBBASIN NO. 103

Total Drainage Area = 0.03536 mi.^{2} = 22.63 Ac.

a. Zoning: RE-43 CN(1hr.) = 86 C = 0.45
Drainage Area = 0.00416 mi.^{2} = 2.66 Ac.
Assume 90% Contributes
∴ Drainage Area = 0.00374 mi.^{2} = 2.40 Ac.

b. Zoning: Hillside (over 10% sloping) CN(1hr.) = ~~98~~ 95 C = 0.70
Drainage Area = 0.0312 mi.^{2} = 19.97 Ac.

Weighted Curve No.

$$CN(1hr.) = \frac{(86)(0.00374) + (\cancel{98}\ 95)(0.0312)}{0.03494} = \cancel{96.7}\ 94.0$$

$$CN(24\ hr.) = \cancel{0.7(95.3 - 94.1) + 94.1} = \cancel{94.9}\ 90.6$$

Weighted 'C' Coefficient:

$$C = \frac{(0.45)(0.00374) + (0.70)(0.0312)}{0.03494} = 0.67$$

Total Contributing Drainage Area = 0.03494 mi.^{2} = 22.37 Ac.

SUBBASIN NO. 104

Drainage Area = 0.04461 mi.^{2} = 28.55 Ac.

Zoning: RE-43
Assume 90% Contributes
∴ Drainage Area = 0.04015 mi.^{2} = 25.70 Ac.
Type D CN(1hr.) = 86
CN(24hr) = 78.8
'C' Coefficient = 0.45

SUBBASIN NO. 200

Drainage Area = 0.18579 mi.^{2} = 118.91 Ac.

Zoning: Hillside (over 10% sloping)
Type D CN(1hr) = ~~98~~ 95
CN(24hr) = ~~97.3~~ 92.2

'C' Coefficient = 0.70

KAMINSKI HUBBARD engineering inc. • Surveying • Civil • Hydrology	Made by D.L.E.	Date 2-16-90	Job No. 0118
	Checked by	Date	Sheet No.
	For		

SUBBASIN NO. 201

Drainage Area = 0.02344 mi.^{2} = 15.00 Ac.

Zoning: RE-43
Assume 90% Contributes
∴ Drainage Area = 0.02110 mi.^{2} = 13.50 Ac.
Type D CN(1hr.) = 86
CN(24hr.) = 78.8

'C' Coefficient = 0.45

SUBBASIN NO. 300

Total Drainage Area = 0.02739 mi.^{2} = 17.53 Ac.

a. Zoning: RE-43 CN(1hr.) = 86 C = 0.45
Drainage Area = 0.00585 mi.^{2} = 3.76 Ac.
Assume 90% Contributes
∴ Drainage Area = 0.00529 mi.^{2} = 3.39 Ac.

b. Zoning: Hillside (over 10% sloping)
CN(1hr.) = ~~98~~ 95 C = 0.70
Drainage Area = 0.02151 mi.^{2} = 13.77 Ac.

Total Contributing Drainage Area = 0.02680 mi.^{2} = 17.16 Ac.

Weighted Curve No.

$$CN(1hr.) = \frac{(86)(0.00529) + (\overset{95}{\cancel{98}})(0.02151)}{0.02680} = \cancel{95.6}\ 93.2$$

$$CN(24hr.) = \overset{0.2}{\cancel{0.6}}(\overset{90.6}{\cancel{94.1}} - \overset{89.8}{\cancel{92.2}}) + \overset{89.8}{\cancel{92.2}} = \cancel{93.5}\ 90.0$$

Weighted 'C' Coefficient

$$C = \frac{(0.45)(0.00529) + (0.70)(0.02151)}{0.02680} = 0.65$$

KAMINSKI HUBBARD engineering inc. • Surveying • Civil • Hydrology	Made by D.L.B.	Date 2-16-90	Job No. 0118
	Checked by	Date	Sheet No.
	For		

SUBBASIN NO. 301

Drainage Area = 0.01385 mi.^{2} = 8.86 Ac.

Zoning: RE-43
Assume 80% Contributes
∴ Drainage Area = 0.01108 mi.^{2} = 7.09 Ac.
Type D CN(1hr.) = 86
CN(24hr.) = 78.8

'C' Coefficient = 0.45

SUBBASIN NO. 302

Drainage Area = 0.02174 mi.^{2} = 13.91 Ac.

Zoning: RE-43
Assume 80% Contributes
∴ Drainage Area = 0.01739 mi.^{2} = 11.13 Ac.
Type D CN(1hr.) = 86
CN(24hr.) = 78.8

'C' Coefficient = 0.45

SUBBASIN NO. 500

Total Drainage Area = 0.04743 mi.^{2} = 30.36 Ac.

a. Zoning: RE-43
Drainage Area = 0.02217 mi.^{2} = 14.19 Ac.
Assume 90% Contributes
∴ Drainage Area = 0.01995 mi.^{2} = 12.77 Ac.

b. Zoning: RE-43
Drainage Area = 0.02527 mi.^{2} = 16.17 Ac.
Assume 80% Contributes
∴ Drainage Area = 0.02021 mi.^{2} = 12.94 Ac.

Total Contributing Drainage Area = 0.04016 mi.^{2} = 25.71 Ac.

Type D CN(1hr.) = 86
CN(24hr) = 78.8

'C' Coefficient = 0.45

KAMINSKI HUBBARD engineering inc. • Surveying • Civil • Hydrology	Made by D.L.B.	Date 2-16-10	Job No. 0118
	Checked by	Date	Sheet No.
	For		

SUBBASIN NO. 510

Drainage Area = 0.03016 mi.^{2} = 19.30 Ac.

Zoning: RE - 43
Assume 90% Contributes
∴ Drainage Area = 0.02714 mi.^{2} = 17.37 Ac.
Type D CN(1hr.) = 86
CN(24hr.) = 78.9

'C' Coefficient = 0.45

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Tatum Blvd. By DLB Date 2-1-90

Location Phoenix, AZ Checked ____ Date ____

Circle one: Present Developed

Circle one: (T_c) T_t through subarea Sub basin #100

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)		Segment ID	A100 - B100		
1. Surface description (table 3-1)			Fallow		
2. Manning's roughness coeff., n (table 3-1) ..			0.05		
3. Flow length, L (total L ≤ 300 ft)	ft		100		
4. Two-yr 24-hr rainfall, P_2	in	1.4	1.4		
5. Land slope, s	ft/ft		0.57		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr		0.027	+	= 0.027

Shallow concentrated flow		Segment ID	B100 - C100		
7. Surface description (paved or unpaved)			Unpaved		
8. Flow length, L	ft		225		
9. Watercourse slope, s	ft/ft		0.77		
10. Average velocity, V (figure 3-1)	ft/s		14		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		0.005	+	= 0.005

Channel flow		Segment ID	C100 - D100	D100 - 100[illegible]
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, p_w	ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft			
15. Channel slope, s	ft/ft		0.362	0.182
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s		14.9	16.7
18. Flow length, L	ft		1160	1100
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		0.022	+ 0.018	≅ 0.04
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr				0.072

or 4.3 min

use 10 min.

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Tatum Blvd. By DLB Date 2-1-90

Location Phoenix, AZ Checked ____ Date ____

Circle one: Present Developed

Circle one: (T_c) T_t through subarea Subbasin #101

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)	Segment ID	A101 – B101		
1. Surface description (table 3-1)		Fallow		
2. Manning's roughness coeff., n (table 3-1) ..		0.05		
3. Flow length, L (total L ≤ 300 ft)	ft	300		
4. Two-yr 24-hr rainfall, P_2	in	1.4		
5. Land slope, s	ft/ft	0.23		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	0.093	+	= 0.093

Shallow concentrated flow	Segment ID	B101 – C101		
7. Surface description (paved or unpaved)		Unpaved		
8. Flow length, L	ft	420		
9. Watercourse slope, s	ft/ft	0.21		
10. Average velocity, V (figure 3-1)	ft/s	7.5		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.016	+	= 0.016

Channel flow	Segment ID	C101 – D101	D101 – E101	E101 – 1001
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, p_w	ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft			
15. Channel slope, s	ft/ft	0.28	0.13	0.05
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s	11.8	10.0	8.5
18. Flow length, L	ft	1000	380	1020
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.024 +	0.011 +	0.033
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr	0.177		

≈ 10.6 min.

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Tatum Blvd. By DLB Date 2-1-90

Location Phoenix, AZ Checked ____ Date ____

Circle one: Present Developed

Circle one: (T_c) T_t through subarea Subbasin #102

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)	Segment ID	A102 - B102		
1. Surface description (table 3-1)		Fallow		
2. Manning's roughness coeff., n (table 3-1) ..		0.05		
3. Flow length, L (total L ≤ 300 ft)	ft	100		
4. Two-yr 24-hr rainfall, P_2	in	1.4		
5. Land slope, s	ft/ft	0.65		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	0.025	+	= 0.025

Shallow concentrated flow	Segment ID	B102 - C102		
7. Surface description (paved or unpaved)		Unpaved		
8. Flow length, L	ft	380		
9. Watercourse slope, s	ft/ft	0.47		
10. Average velocity, V (figure 3-1)	ft/s	11.0		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.010	+	= 0.010

Channel flow	Segment ID	C102 - D102	D102 - 1002
12. Cross sectional flow area, a	ft^2		
13. Wetted perimeter, p_w	ft		
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft		
15. Channel slope, s	ft/ft	0.096	0.036
16. Manning's roughness coeff., n			
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s	8.4	4.7
18. Flow length, L	ft	1080	400
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.036 +	0.024 = 0.06
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr		0.095

≈ 5.7 min

Use 10min

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Tatum Blvd. By DLB Date 2-1-90

Location Phoenix, AZ Checked ____ Date ____

Circle one: Present Developed

Circle one: (T_c) T_t through subarea Sub basin # 103

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)		Segment ID	A103 - B103		
1. Surface description (table 3-1)			Fallow		
2. Manning's roughness coeff., n (table 3-1) ..			0.05		
3. Flow length, L (total L ≤ 300 ft)	ft		300		
4. Two-yr 24-hr rainfall, P_2	in		1.4		
5. Land slope, s	ft/ft		0.67		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr		0.061	+	= 0.061

Shallow concentrated flow		Segment ID	B103 - C103		
7. Surface description (paved or unpaved)			Unpaved		
8. Flow length, L	ft		380		
9. Watercourse slope, s	ft/ft		0.65		
10. Average velocity, V (figure 3-1)	ft/s		13.0		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		0.008	+	= 0.008

Channel flow		Segment ID	C103 - D103	D103 - E103	E103 - 1003
12. Cross sectional flow area, a	ft^2				
13. Wetted perimeter, p_w	ft				
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft				
15. Channel slope, s	ft/ft		0.26	0.11	0.038
16. Manning's roughness coeff., n					
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s		10.1	9.0	8.0
18. Flow length, L	ft		320	380	260
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		0.023	+ 0.012	+ = 0.009

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) ..... hr 0.113

≈ 6.8 min
Use 10 min

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Tatum Blvd. By DLB Date 2-2-90

Location Phoenix AZ Checked ____ Date ____

Circle one: Present Developed

Circle one: (T_c) T_t through subarea Subbasin #104

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)		Segment ID	A104 - B104		
1. Surface description (table 3-1)			Fallow		
2. Manning's roughness coeff., n (table 3-1) ..			0.05		
3. Flow length, L (total L ≤ 300 ft)	ft		100		
4. Two-yr 24-hr rainfall, P_2	in		1.4		
5. Land slope, s	ft/ft		0.21		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr		0.04	+	= 0.04

Shallow concentrated flow		Segment ID	B104 - C104		
7. Surface description (paved or unpaved)			Unpaved		
8. Flow length, L	ft		140		
9. Watercourse slope, s	ft/ft		0.078		
10. Average velocity, V (figure 3-1)	ft/s		4.5		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		0.01	+	= 0.01

Channel flow		Segment ID	C104 - D104	D104 - 1004
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, p_w	ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft			
15. Channel slope, s	ft/ft		0.085	0.040
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s		6.2	4.6
18. Flow length, L	ft		280	1260
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		0.013	+ 0.076 = 0.089

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) ..... hr 0.139 ≈ 8.3 min

Use 10 min = 0.1 hr.

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Tatum Blvd. By DLB Date 2-2-90

Location Phoenix, AZ Checked ____ Date ____

Circle one: Present Developed

Circle one: (T_c) T_t through subarea Sub basin #200

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)	Segment ID	A200 – B200		
1. Surface description (table 3-1)		Fallow		
2. Manning's roughness coeff., n (table 3-1) ..		0.05		
3. Flow length, L (total L ≤ 300 ft)	ft	200		
4. Two-yr 24-hr rainfall, P_2	in	1.4		
5. Land slope, s	ft/ft	0.50		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	0.049	+	= 0.049

Shallow concentrated flow	Segment ID	B200 – C200		
7. Surface description (paved or unpaved)		Unpaved		
8. Flow length, L	ft	720		
9. Watercourse slope, s	ft/ft	0.40		
10. Average velocity, V (figure 3-1)	ft/s	10.0		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.02	+	= 0.02

Channel flow	Segment ID	C200 – D200	D200 – E200	E200 – 2000
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, p_w	ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft			
15. Channel slope, s	ft/ft	0.080	0.042	0.029
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ ~~Assume V = 9.0 fps~~ Compute V	ft/s	9.9	9.7	9.5
18. Flow length, L	ft	1120	480	1020
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.031	+ 0.014	+ 0.030
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr			0.144

velocity computed using Avg. V Sect.

≈ 8.6 min.
use 10 min

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Tatum Blvd. By DLB Date 2-2-90

Location Phoenix, AZ Checked ____ Date ____

Circle one: Present Developed

Circle one: (T_c) T_t through subarea Sub basin # 201

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)	Segment ID	A201 - B201		
1. Surface description (table 3-1)		Fallow		
2. Manning's roughness coeff., n (table 3-1) ..		0.05		
3. Flow length, L (total L ≤ 300 ft)	ft	220		
4. Two-yr 24-hr rainfall, P_2	in	1.4		
5. Land slope, s	ft/ft	0.59		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	0.050	+	= 0.050

Shallow concentrated flow	Segment ID	B201 - C201	C201 - D201	
7. Surface description (paved or unpaved)		Unpaved	Unpaved	
8. Flow length, L	ft	260	200	
9. Watercourse slope, s	ft/ft	0.39	0.10	
10. Average velocity, V (figure 3-1)	ft/s	10.0	5.2	
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.007	+ 0.011	≈ 0.018

Channel flow	Segment ID	D201 - E201	E201 - 2001	
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, p_w	ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft			
15. Channel slope, s	ft/ft	0.086	0.034	
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s	6.5	5.6	
18. Flow length, L	ft	560	580	
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.024	+ 0.029	= 0.053
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr			0.121

≈ 7.3 min
use 10 min
= 0.1 hr

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Tatum Blvd. By DLB Date 2-2-90

Location Phoenix, AZ Checked ____ Date ____

Circle one: Present Developed

Circle one: (T_c) T_t through subarea Sub basin #300

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)	Segment ID	A300-B300		
1. Surface description (table 3-1)		Fallow		
2. Manning's roughness coeff., n (table 3-1) ..		0.05		
3. Flow length, L (total L ≤ 300 ft)	ft	250		
4. Two-yr 24-hr rainfall, P_2	in	1.4		
5. Land slope, s	ft/ft	0.61		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	0.054	+	= 0.054

Shallow concentrated flow	Segment ID	B300-C300		
7. Surface description (paved or unpaved)		Unpaved		
8. Flow length, L	ft	360		
9. Watercourse slope, s	ft/ft	0.44		
10. Average velocity, V (figure 3-1)	ft/s	10.5		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.010	+	= 0.010

Channel flow	Segment ID	C300-D300	D300-3000	
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, p_w	ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft			
15. Channel slope, s	ft/ft	0.18	0.035	
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s	8.3	5.5	
18. Flow length, L	ft	400	530	
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.013	+ 0.027	= 0.04

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) ..... hr 0.104

≈ 6.2 min

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Tatum Blvd. By DLB Date 2-2-90

Location Phoenix, AZ Checked ____ Date ____

Circle one: Present Developed

Circle one: (T_c) T_t through subarea Subbasin #301

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)		Segment ID	A301-B301		
1. Surface description (table 3-1)			Fallow		
2. Manning's roughness coeff., n (table 3-1) ..			0.05		
3. Flow length, L (total L ≤ 300 ft)	ft		200		
4. Two-yr 24-hr rainfall, P_2	in		1.4		
5. Land slope, s	ft/ft		0.03		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr		0.152	+	= 0.152
Shallow concentrated flow		Segment ID	B301-C301		
7. Surface description (paved or unpaved)			Paved		
8. Flow length, L	ft		380		
9. Watercourse slope, s	ft/ft		0.015		
10. Average velocity, V (figure 3-1)	ft/s		2.6		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		0.041	+	= 0.041
Channel flow		Segment ID	C301-3001		
12. Cross sectional flow area, a	ft^2				
13. Wetted perimeter, p_w	ft				
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft				
15. Channel slope, s	ft/ft		0.018		
16. Manning's roughness coeff., n					
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s		3.6		
18. Flow length, L	ft		320		
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		0.025	+	= 0.025
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr				0.218

≈ 13.1 min

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Tatum Blvd. By DLB Date 2-2-90

Location Phoenix, AZ Checked ____ Date ____

Circle one: Present Developed

Circle one: (T_c) T_t through subarea Subbasin #302

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)		Segment ID	A302-B302		
1. Surface description (table 3-1)			Fallow		
2. Manning's roughness coeff., n (table 3-1) ..			0.05		
3. Flow length, L (total L ≤ 300 ft)	ft		70		
4. Two-yr 24-hr rainfall, P_2	in		1.4		
5. Land slope, s	ft/ft		0.09		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr		0.042	+	= 0.042

Shallow concentrated flow		Segment ID			
7. Surface description (paved or unpaved)					
8. Flow length, L	ft				
9. Watercourse slope, s	ft/ft				
10. Average velocity, V (figure 3-1)	ft/s				
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr			+	=

Channel flow		Segment ID	B302-C302	C302-D302	
12. Cross sectional flow area, a	ft^2				
13. Wetted perimeter, p_w	ft				
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft				
15. Channel slope, s	ft/ft		0.037	0.021	
16. Manning's roughness coeff., n					
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s		3.1	6.5	
18. Flow length, L	ft		1200	490	
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		0.108	+ 0.021	= 0.129

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) ..... hr 0.171

≈ 10.3 min

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Tatum Blvd. By D.L.B. Date 2-13-90

Location Mockingbird Ln. to Shea Blvd. Checked ____ Date ____

Circle one: Present Developed

Circle one: (T_c) T_t through subarea Subbasin #500

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)	Segment ID	A500 - B500		
1. Surface description (table 3-1)		Fallow		
2. Manning's roughness coeff., n (table 3-1) ..		0.05		
3. Flow length, L (total L ≤ 300 ft)	ft	300		
4. Two-yr 24-hr rainfall, P_2	in	1.4		
5. Land slope, s	ft/ft	0.053		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	0.167	+	= 0.167

Shallow concentrated flow	Segment ID	B500 - C500		
7. Surface description (paved or unpaved)		Unpaved		
8. Flow length, L	ft	300		
9. Watercourse slope, s	ft/ft	0.053		
10. Average velocity, V (figure 3-1)	ft/s	3.7		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.023	+	= 0.023

Channel flow	Segment ID	C500 - D500	D500 - 5030
12. Cross sectional flow area, a	ft^2		
13. Wetted perimeter, p_w	ft		
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft		
15. Channel slope, s	ft/ft	0.033	0.027
16. Manning's roughness coeff., n			
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s	5.6	4.6
18. Flow length, L	ft	1500	920
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.074 +	0.056 = 0.130

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) ..... hr 0.320

= 19.2 min

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project *Tatum Blvd.* By *D.L.B.* Date *2-13-90*

Location *Mockingbird Ln. to Shea Blvd.* Checked _____ Date _____

Circle one: Present Developed

Circle one: (T_c) T_t through subarea *Subbasin #510*

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)		Segment ID	A510-B510		
1. Surface description (table 3-1)			Fallow		
2. Manning's roughness coeff., n (table 3-1) ..			0.05		
3. Flow length, L (total L ≤ 300 ft)	ft		300		
4. Two-yr 24-hr rainfall, P_2	in		1.4		
5. Land slope, s	ft/ft		0.040		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr		0.187	+	= 0.187

Shallow concentrated flow		Segment ID	B510-C510		
7. Surface description (paved or unpaved)			Unpaved		
8. Flow length, L	ft		620		
9. Watercourse slope, s	ft/ft		0.045		
10. Average velocity, V (figure 3-1)	ft/s		3.4		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		0.051	+	= 0.051

Channel flow		Segment ID	C510-D510	D510-S010
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, p_w	ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft			
15. Channel slope, s	ft/ft		0.031	0.032
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s		4.5	3.0
18. Flow length, L	ft		260	1080
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		0.016	+ 0.100 = 0.116

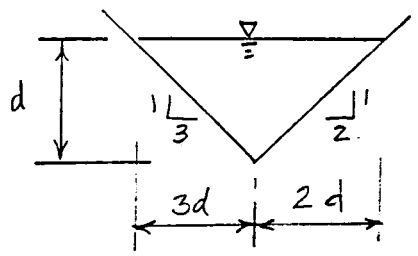
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) ..... hr 0.354

≈ 21.2 min

KAMINSKI HUBBARD engineering inc. • Surveying • Civil • Hydrology	Made by D.L.B.	Date 2-2-90	Job No. 0118
	Checked by	Date	Sheet No.
	For Channel X-Sections		

SUBBASIN #100

$Q = 1.6\ cfs/Ac \times 7.1\ Ac \approx 11.4\ cfs$



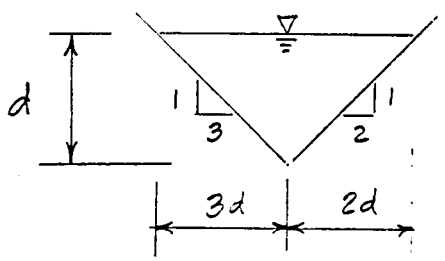
$n = 0.03$
$S = 0.36\ ft/ft$

$A = 2.5d^2$
$P = \sqrt{15}\ d$
$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$

Try $d = 0.55'$ → $A = 0.76\ ft^2$, $P = 2.13\ ft$

$Q = 11.3\ cfs$ OK

$\therefore V = \frac{Q}{A} = \frac{11.3}{0.76} = 14.9\ fps$



$n = 0.030$
$S = 0.18\ ft/ft$

$Q = 1.6\ cfs/Ac \times 30.72\ Ac \approx 49\ cfs$

$A = 2.5d^2$
$P = \sqrt{15}\ d$

Try $d = 1.10'$ → $A = 3.03\ ft^2$, $P = 4.26\ ft$

$Q = 50.6\ cfs$ OK

$\therefore V = \frac{Q}{A} = \frac{50.6}{3.03} = 16.7\ fps$

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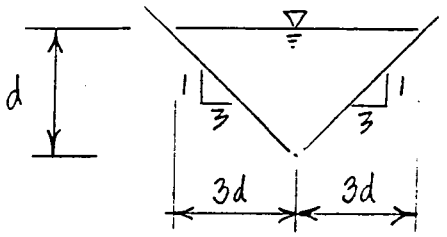
	Checked by	Date	Sheet No.
	For Channel X-Section		

SUBBASIN #101

$Q = 1.6\ CFS/Ac \times 4.72\ Ac = 7.55\ CFS$



$n = 0.030$
$S = 0.23\ '/ft$

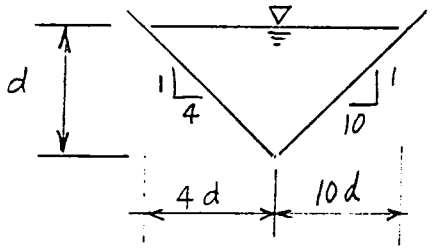
$A = 3d^2$
$P = \sqrt{20}\ d$

$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$

Try $d = 0.45'$ → $A = 0.61\ ft^2$
$P = 2.01\ ft$

$Q = 7.2\ CFS \approx 7.5\ CFS$ ok

$\therefore V = Q/A = \frac{7.2}{0.61} = 11.8\ fps$



$n = 0.030$
$S = 0.05'/ft.$

$Q = 1.6\ CFS/Ac \times 42.52\ Ac = 68\ CFS$

$A = 7d^2$
$P = \sqrt{118}\ d$

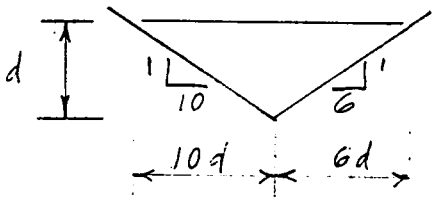
Try $d = 1.05'$ → $A = 7.71\ ft^2$
$P = 11.41\ ft$

$Q = 65.9\ CFS \approx 68\ CFS$ ok

$\therefore V = Q/A = \frac{65.9}{7.71} = 8.5\ fps$

SUBBASIN #102

#C102 – #D102



$n = 0.030$
$S = 0.096\ '/ft$

$Q = 1.6\ CFS/Ac \times \cancel{2.75}\ 15.61\ Ac = 25\ CFS$

$A = 8d^2$
$P = \sqrt{138}\ d$

Try $d = 0.23'$ → $A = 2.88\ ft^2$
$P = 7.04\ ft$

$Q = 24.3\ CFS$ ok

$\therefore V = \frac{24.3}{2.88} = 8.4\ fps$

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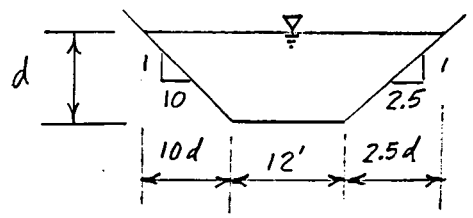
SUB BASIN #102

#D102 – #100Z



$n = 0.030$
$S = 0.036'/ft$

$Q = 1.6\ cfs/Ac \times 17.1\ Ac = 27.3\ cfs$

$A = 12d + 6.25d^2$
$P = \sqrt{108.25}\,d + 12$

$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$

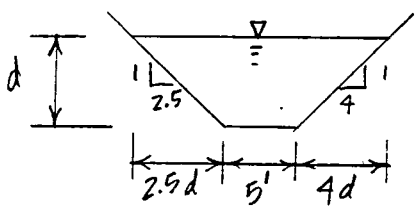
Try $d = 0.40'$ → $A = 5.90\ ft^2$, $P = 16.16\ ft$

$Q = 27.5\ cfs$ ok

$\therefore V = \frac{Q}{A} = \frac{27.5}{5.9} = 4.74\ fps$

SUB BASIN #103

#C103 to #D103



$n = 0.030$
$S = 0.26'/ft$

$Q = 1.6\ cfs/Ac \times 9.2\ Ac \cong 15\ cfs$

$A = 5d + 3.25d^2$

$P = \sqrt{24.25}\,d + 5$

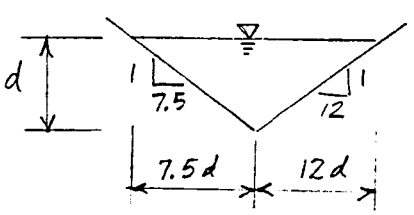
Try $d = 0.27'$ → $A = 1.59\ ft^2$, $P = 6.33\ ft$

$Q = 16\ cfs$ ok

$\therefore V = Q/A = \frac{16}{1.59} = 10.1\ fps$

SUBBASIN #104

#D104 to #1004



$n = 0.030$
$S = 0.04\ ft/ft$

D.A. = 8.86 Ac.
Assume $t_c < 10\ min$, → ∴ $i = 2.4\ in/hr.$
$Q = CIA = (0.45)(2.4)(8.86) \cong 10\ cfs$

$A = 9.75\,d^2$
$P = \sqrt{202.25}\,d$

Try $d = 0.47'$ → $A = 2.15\ ft^2$, $P = 6.68\ ft$

$Q = 10\ cfs$ ok

$\therefore V = Q/A = 10/2.15 = 4.6\ fps$

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ENTIRE DRAINAGE AREA

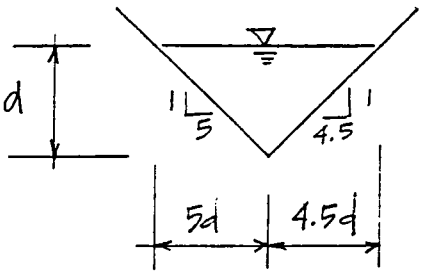
Assume $t_c = 15$ min → $i = 2.3$ in/hr (2-Year Storm)

$Q = CIA = (0.70)(2.3)(118.91)$

$= 166$ CFS

SUBBASIN # 200

Section 1 C200 – D200



$Q = 1.6$ CFS/Ac x 22.09 Ac ≅ 35 CFS

$A = \frac{1}{2}(5d^2 + 4.5d^2) = 4.75d^2$

$P = \sqrt{d^2 + 25d^2 + d^2 + 20.25d^2}$

$= \sqrt{47.25}\, d$

$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$

$n = 0.030$

$S = 0.08$ '/ft

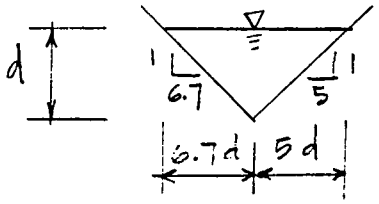
Try $d = 0.86'$ → $A = 3.51$ ft^2

$P = 5.91$ ft

$Q = 34.8$ CFS ok

$\therefore V = \frac{34.8}{3.51} = 9.9$ fps

E200 – 2000



$A = 5.85d^2$

$P = \sqrt{71.89}\, d$

$n = 0.030$

$S = 0.029$ '/ft

Try $d = 1.75'$ → $A = 17.92$ ft^2

$P = 14.94$ ft

$Q = 171$ cfs ok

$\therefore V = 171/17.92 = 9.5$ fps

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	Checked by	Date	Sheet No.
	For Channel X-Section		

SUBBASIN #201

#D201 to #E201

$S = 0.086$ ft/ft

Page 26 (C.D.S. Storm Drain Manual)

$A = 5.75$ Ac.

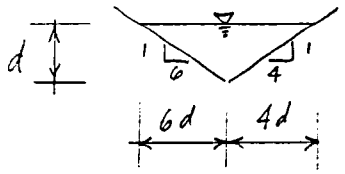
$t_c = 10$ min. $\rightarrow$ $i = 2.4$ in/hr.

$Q = CIA = (0.45)(2.4)(5.75) = 6.2$ CFS

$V = 7$ fps

Round down to 6.5 fps, to account for nat. grd.

#E301 to #2001



$n = 0.030$

$S = 0.034$ ft/ft

$A = 12.8$ Ac.

$t_c = 10$ min. $\longrightarrow$ $i = 2.4$ in/hr

$Q = CIA = (0.45)(2.4)(12.8) \cong 14$ CFS

$A = 5d^2$

$P = \sqrt{54}\, d$

$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$

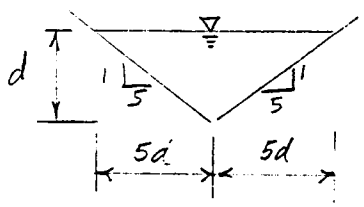
Try $d = 0.71'$ $\rightarrow$ $A = 2.52$ ft^2 & $P = 5.22$ ft

$Q = 14.2$ CFS OK

$\therefore V = Q/A = 14.2/2.52 = 5.6$ fps

SUBBASIN #300

#C300 to #D300



$n = 0.030$

$S = 0.18$ ft/ft

D.A. = 3.3 Ac

$Q = 1.6$ CFS/Ac $\times$ 3.3 Ac $= 5.3$ CFS

$A = 5d^2$

$P = \sqrt{52}\, d$

Try $d = 0.36'$ $\rightarrow$ $A = 0.65$ ft^2, $P = 2.60$ ft

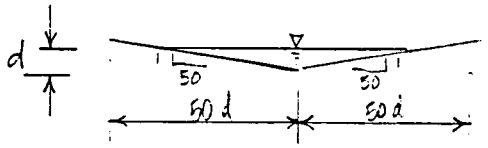
$Q = 5.4$ CFS OK

$\therefore V = Q/A = 5.4/0.65 = 8.3$ fps

#D300 to #3000

D.A. = 9.55 Ac.

$Q = [(0.70)(6.57) + (0.45)(2.99)](2.4) = 14.3$ CFS



$n = 0.015$

$S = 0.035$ ft/ft

$A = 50d^2$

$P = \sqrt{5002}\, d$

Try $d = 0.23'$ $\rightarrow$ $A = 2.65$ ft^2, $P = 16.27$ ft

$Q = 14.6$ CFS OK

$\therefore V = Q/A = \frac{14.6}{2.65} = 5.5$ fps

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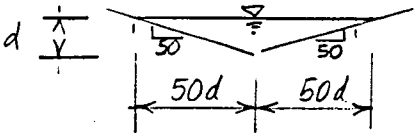
	For		

SUBBASIN #301

#B301 to #C301



$n = 0.015$

$S = 0.018$ ft/ft

D.A. = 7.07 Ac.

t_c = 10 min. → i = 2.4 in/hr

$Q = CIA = (0.45)(2.4)(7.07) = 7.6$ CFS

$A = 50d^2$ $\qquad Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$

$P = \sqrt{5002}\, d$

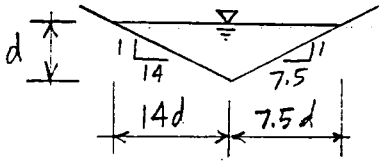
Try $d = 0.2'$ → $A = 2.00$ ft^2, $P = 14.14$ ft

$Q = 7.2$ CFS ok

$\therefore V = Q/A = 7.2/2 = 3.6$ fps

SUBBASIN #302

#B302 - #C302



$n = 0.030$

$S = 0.037$ ft/ft

D.A. = 2.20 Ac.

t_c = 10 min. → i = 2.4 in/hr

$Q = CIA = (0.45)(2.4)(2.20)$
$= 2.4$ CFS

$A = 10.75 d^2$

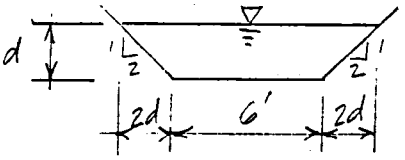
$P = \sqrt{254.25}\, d$

Try $d = 0.27'$ → $A = 0.78$ ft^2, $P = 4.31$ ft

$Q = 2.4$ CFS ok

$\therefore V = Q/A = 2.4/0.78 = 3.1$ fps

#C302 - #3002



$n = 0.013$

$S = 0.021$ ft/ft

D.A. = 10 Ac.

t_c = 10 min. → i = 2.4 in/hr

$Q = CIA = (0.45)(2.4)(10) = 10.8$ CFS

$A = 6d + 2d^2$

$P = \sqrt{10}\, d + 6$

Try $d = 0.26'$ → $A = 1.70$ ft^2 & $P = 6.82$ ft

$Q = 11.1$ CFS ok

$\therefore V = Q/A = 11.1/1.70 = 6.5$ fps

APPENDIX C-1

DRAINAGE AREA NO. 2

* HEC-1 OUTPUT FOR SUB-BASINS 400 * 410

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID                 CITY OF PHOENIX PROJECT NO. P-886515
  2           ID              TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
  3           ID           KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 0118
  4           ID                     HEC-1 FILENAME :  118-29.DAT
  5           ID              PRELIMINARY RUN - 2 YEAR - 1 HOUR STORM
  6           IT       5 07FEB90    1000     300 08FEB90    1000
  7           IO       5

  8           KK     400
  9           KM                    Subarea No. 400/410
 10           BA   .1496
 11           IN     1.5 07FEB90    1000
 12           PB    0.88
 13           PC    .000    .010    .020    .030    .040    .050    .065    .080    .100
 14           PC    .120    .140    .160    .180    .225    .300    .400    .530    .600
 15           PC    .640    .665    .700    .725    .750    .775    .800    .820    .840
 16           PC    .858    .875    .891    .906    .919    .931    .942    .952    .961
 17           PC    .969    .977    .985    .993   1.000
 18           LS            89.8
 19           UD     .13
 20           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	400	53.	.50	4.	1.	1.	.15		

*** NORMAL END OF HEC-1 ***

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID                 CITY OF PHOENIX PROJECT NO. P-886515
  2           ID              TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
  3           ID           KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 0118
  4           ID                   HEC-1 FILENAME :  118-28.DAT
  5           ID              PRELIMINARY RUN - 10 YEAR - 1 HOUR STORM.
  6           IT       5 07FEB90    1000     300 08FEB90    1000
  7           ID       5

  8           KK     400
  9           KM                     Subarea No. 400/410
 10           BA   .1496
 11           IN     1.5 07FEB90    1000
 12           PB    1.61
 13           PC    .000    .010    .020    .030    .040    .050    .065    .080    .100
 14           PC    .120    .140    .160    .180    .225    .300    .400    .530    .600
 15           PC    .640    .665    .700    .725    .750    .775    .800    .820    .840
 16           PC    .858    .875    .891    .906    .919    .931    .942    .952    .961
 17           PC    .969    .977    .985    .993   1.000
 18           LS            89.8
 19           UD     .13
 20           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	400	176.	.50	12.	3.	3.	.15		

*** NORMAL END OF HEC-1 ***

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID                 CITY OF PHOENIX PROJECT NO. P-886515
  2           ID              TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
  3           ID           KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 0118
  4           ID                     HEC-1 FILENAME :  118-27.DAT
  5           ID              PRELIMINARY RUN - 25 YEAR - 1 HOUR STORM.
  6           IT       5 07FEB90    1000     300 08FEB90    1000
  7           ID       5

  8           KK     400
  9           KM                    Subarea No. 400/410
 10           BA   .1496
 11           IN     1.5 07FEB90    1000
 12           PB    2.02
 13           PC    .000    .010    .020    .030    .040    .050    .065    .080    .100
 14           PC    .120    .140    .160    .180    .225    .300    .400    .530    .600
 15           PC    .640    .665    .700    .725    .750    .775    .800    .820    .840
 16           PC    .858    .875    .891    .906    .919    .931    .942    .952    .961
 17           PC    .969    .977    .985    .993   1.000
 18           LS            89.8
 19           UD     .13
 20           ZZ
```

```
****************************************
*                                      *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*            FEBRUARY 1981             *
*          REVISED 01 JUN 88           *
*                                      *
* RUN DATE  03/28/1990  TIME  11:09:33 *
*                                      *
****************************************
```

```
****************************************
*                                      *
*   U.S. ARMY CORPS OF ENGINEERS       *
* THE HYDROLOGIC ENGINEERING CENTER    *
*          609 SECOND STREET           *
*       DAVIS, CALIFORNIA 95616        *
*           (916) 551-1748             *
*                                      *
****************************************
```

CITY OF PHOENIX PROJECT NO. P-886515
TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 0118
HEC-1 FILENAME : 118-27.DAT
PRELIMINARY RUN - 25 YEAR - 1 HOUR STORM

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

  IT         HYDROGRAPH TIME DATA
                   NMIN          5  MINUTES IN COMPUTATION INTERVAL
                  IDATE     7FEB90  STARTING DATE
                  ITIME       1000  STARTING TIME
                     NQ        289  NUMBER OF HYDROGRAPH ORDINATES
                 NDDATE     8FEB90  ENDING DATE
                 NDTIME       1000  ENDING TIME
                  ICENT         19  CENTURY MARK

            COMPUTATION INTERVAL     .08 HOURS
                 TOTAL TIME BASE   24.00 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	400	255.	.50	18.	4.	4.	.15		

*** NORMAL END OF HEC-1 ***

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID                 CITY OF PHOENIX PROJECT NO. P-886515
  2           ID              TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
  3           ID           KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 0118
  4           ID                    HEC-1 FILENAME :  118-26.DAT
  5           ID              PRELIMINARY RUN - 50 YEAR - 1 HOUR STORM.
  6           IT       5 07FEB90    1000     300 08FEB90    1000
  7           IO       5

  8           KK     400
  9           KM                    Subarea No. 400/410
 10           BA   .1496
 11           IN     1.5 07FEB90    1000
 12           PB    2.35
 13           PC    .000    .010    .020    .030    .040    .050    .065    .080    .100
 14           PC    .120    .140    .160    .180    .225    .300    .400    .530    .600
 15           PC    .640    .665    .700    .725    .750    .775    .800    .820    .840
 16           PC    .858    .875    .891    .906    .919    .931    .942    .952    .961
 17           PC    .969    .977    .985    .993   1.000
 18           LS            89.8
 19           UD     .13
 20           ZZ
```

```
**************************************
*                                    *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1) *
*           FEBRUARY 1981            *
*          REVISED 01 JUN 88         *
*                                    *
* RUN DATE  03/28/1990  TIME  11:07:37 *
*                                    *
**************************************
```

```
**************************************
*                                    *
*   U.S. ARMY CORPS OF ENGINEERS     *
* THE HYDROLOGIC ENGINEERING CENTER  *
*         609 SECOND STREET          *
*      DAVIS, CALIFORNIA 95616       *
*          (916) 551-1748            *
*                                    *
**************************************
```

CITY OF PHOENIX PROJECT NO. P-886515
TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 0118
HEC-1 FILENAME : 118-26.DAT
PRELIMINARY RUN - 50 YEAR - 1 HOUR STORM

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

   IT         HYDROGRAPH TIME DATA
                    NMIN          5  MINUTES IN COMPUTATION INTERVAL
                   IDATE     7FEB90  STARTING DATE
                   ITIME       1000  STARTING TIME
                      NQ        299  NUMBER OF HYDROGRAPH ORDINATES
                  NDDATE     8FEB90  ENDING DATE
                  NDTIME       1000  ENDING TIME
                   ICENT         19  CENTURY MARK

             COMPUTATION INTERVAL     .08 HOURS
                  TOTAL TIME BASE   24.00 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	400	321.	.50	22.	6.	6.	.15		

*** NORMAL END OF HEC-1 ***

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID                 CITY OF PHOENIX PROJECT NO. P-886515
  2           ID              TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
  3           ID           KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 0118
  4           ID                     HEC-1 FILENAME :  118-25.DAT
  5           ID              PRELIMINARY RUN - 100 YEAR - 1 HOUR STORM
  6           IT       5 07FEB90    1000     300 09FEB90    1000
  7           IO       5

  8           KK     400
  9           KM                    Subarea No. 400/410
 10           BA   .1496
 11           IN     1.5 07FEB90    1000
 12           PB    2.66
 13           PC    .000    .010    .020    .030    .040    .050    .065    .080    .100
 14           PC    .120    .140    .160    .180    .225    .300    .400    .530    .600
 15           PC    .640    .665    .700    .725    .750    .775    .800    .820    .840
 16           PC    .858    .875    .891    .906    .919    .931    .942    .952    .961
 17           PC    .969    .977    .985    .993   1.000
 18           LS            89.8
 19           UD     .13
 20           ZZ
```

```
****************************************
*                                      *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*            FEBRUARY 1981             *
*          REVISED 01 JUN 88           *
*                                      *
* RUN DATE  03/29/1990  TIME  11:05:13 *
*                                      *
****************************************
```

```
****************************************
*                                      *
*   U.S. ARMY CORPS OF ENGINEERS       *
* THE HYDROLOGIC ENGINEERING CENTER    *
*          609 SECOND STREET           *
*       DAVIS, CALIFORNIA 95616        *
*           (916) 551-1748             *
*                                      *
****************************************
```

```
                    CITY OF PHOENIX PROJECT NO. P-886515
                  TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
              KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 0118
                        HEC-1 FILENAME :  11B-25.DAT
                  PRELIMINARY RUN - 100 YEAR - 1 HOUR STORM

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

    IT        HYDROGRAPH TIME DATA
                    NMIN          5  MINUTES IN COMPUTATION INTERVAL
                   IDATE     7FEB90  STARTING DATE
                   ITIME       1000  STARTING TIME
                      NQ        289  NUMBER OF HYDROGRAPH ORDINATES
                  NDDATE     8FEB90  ENDING DATE
                  NDTIME       1000  ENDING TIME
                   ICENT         19  CENTURY MARK

             COMPUTATION INTERVAL     .08 HOURS
                  TOTAL TIME BASE   24.00 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
```

APPENDIX E

DRAINAGE AREA NO. 4

* DESIGN CALCULATIONS

KAMINSKI HUBBARD engineering inc. • Surveying • Civil • Hydrology	Made by D.L.B.	Date 3-16-90	Job No. 0118
	Checked by	Date	Sheet No.
	For		

DRAINAGE CALCULATIONS FOR SUBBASIN NO. 453

(1) Zoning: 100% RE-43
Drainage Area, A = 7.21 Ac.
'C' Coefficient = 0.45
Time of Conc., t_c = 10 min

Rational Eq.: $Q = CIA$

Description	2 YR.	10 YR.	25 YR.	50 YR.	100 YR
Intensity, in/hr	2.4	3.8	4.5	5.0	5.5
Q, CFS	7.8	12.3	14.6	16.2	17.8

(2) Retention Basin Storage

Surface Area = 30,750 ft^2 = 0.70592 Ac.
Avg. Depth = 3 ft

∴ Volume = (30,750)(3) = 92,250 ft^3

From Collar, Williams & White Grading Plan:
Vol. = 34,340 ft^3

(3) Retention Basin Storage vs. Peak Discharge (2hr. Duration) Using City of Phoenix Method

Required Capacity = 7200 Q (ft^3)

Description	2 YR.	10 YR.	25 YR.	50 YR	100 YR
Intensity, in/hr	0.48	0.80	0.96	1.10	1.25
Q, CFS	1.6	2.6	3.1	3.6	4.1
Volume (ft^3)	11,213	18,688	22,426	25,696	29,201

KAMINSKI HUBBARD engineering inc. • Surveying • Civil • Hydrology	Made by D. L. B.	Date 3-19-90	Job No. 0118
	Checked by	Date	Sheet No.
	For		

DRAINAGE CALCULATIONS FOR SUBBASIN NO. 452

(1) Zoning : 100% RE-43
Drainage Area, A = 26.73 Ac.
'C' Coefficient = 0.45
Time of Conc., t_c = 32.5 min.

Rational Eq.: Q = CIA

Description	2-YR.	10-YR.	25 YR.	50 YR.	100 YR.
Intensity, in/hr	1.3	2.1	2.5	2.85	3.2
Q, CFS	15.6	25.3	30.1	34.3	38.5

(2) Retention Basin Storage

Surface Area = 28,150 ft^2 = 0.64624 Ac.
Avg. Depth = 3 ft.

∴ Volume = 84,450 ft^3

From Collar, Williams & White Grading Plan:
Vol. = 87,100 ft^3

(3) Retention Basin Storage vs. Peak Storage (2-hr. Duration) Using City of Phoenix Method

Required Capacity = 7200 Q (ft^3)

Description	2 YR	10 YR.	25 YR.	50 YR.	100 YR.
Intensity, in/hr	0.48	0.80	0.96	1.10	1.25
Q, CFS	5.8	9.6	11.5	13.2	15.0
Volume, ft^3	41,570	69,294	83,141	95,266	108,257

KAMINSKI HUBBARD engineering inc. • Surveying • Civil • Hydrology	Made by D.L.B.	Date 3-19-90	Job No. 0118
	Checked by	Date	Sheet No.
	For		

DRAINAGE CALCS. SUBBASIN NO. 452 (CONT'D)

(4) Retention Basin Storage vs. Peak Storage (t_c)

$$\text{Volume } (ft^3) = Q_i \times 2.67 \times t_c \times 0.5 \times 60$$

Description	2YR.	10YR	25YR.	50YR.	100YR.
Q, CFS	15.6	25.3	30.1	34.3	38.5
Volume, ft^3	12,496	20,265	24,110	27,474	30,839

DRAINAGE AREA CALCULATIONS FOR SUBBASIN NO. 451

(1) Zoning: 100% RE-43
Drainage Area, A = 14.26 Ac.
'C' Coefficient = 0.45
Time of Conc., t_c = 10 min.

Rational Eq.: $Q = CIA$

Description	2 YR.	10 YR.	25 YR.	50 YR.	100 YR.
Intensity, in/hr	2.4	3.8	4.5	5.0	5.5
Q, CFS	15.4	24.4	28.9	32.1	35.3

KAMINSKI HUBBARD engineering inc. • Surveying • Civil • Hydrology	Made by D.L.B.	Date 3-1-90	Job No. 0118
	Checked by	Date	Sheet No.
	For		

SUBBASIN NO. 441

Total Drainage Area = 0.01195 mi.² = 7.65 Ac.
CN(24hr) = 78.8
Zoning: RE-43 CN(1hr) = 86 C = 0.45
Assume 90% Contributes
∴ Drainage Area = 0.01076 mi.² = 6.88 Ac.

SUBBASIN NO. 453

Total Drainage Area = 0.01251 mi.² = 8.01 Ac.
CN(24hr) = 78.8
Zoning: RE-43 CN(1hr) = 86 C = 0.45
Assume 90% Contributes
∴ Drainage Area = 0.01126 mi.² = 7.21 Ac.

SUBBASIN NO. 452

Total Drainage Area = 0.04641 mi.² = 29.70 Ac.
CN(24hr) = 78.8
Zoning: RE-43 CN(1hr.) = 86 C = 0.45
Assume 90% Contributes
∴ Drainage Area = 0.04177 mi.² = 26.73 Ac.

SUBBASIN NO. 451

Total Drainage Area = 0.02476 mi.² = 15.85 Ac.
CN(24hr) = 78.8
Zoning: RE-43 CN(1hr.) = 86 C = 0.45
Assume 90% Contributes
∴ Drainage Area = 0.02229 mi.² = 14.26 Ac.

* Time of Concentration for Sub-basins #451 and #453 are assumed to be 10 minutes because of the size of the sub-basins.

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Tatum Blvd. By D.L.B. Date 3-16-90

Location Mockingbird Lane to Shea Blvd. Checked ____ Date ____

Circle one: Present Developed

Circle one: (T_c) T_t through subarea Subbasin # 452

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)		Segment ID	A452-B452		
1. Surface description (table 3-1)			Fallow		
2. Manning's roughness coeff., n (table 3-1) ..			0.05		
3. Flow length, L (total L $\leq$ 300 ft)	ft		300		
4. Two-yr 24-hr rainfall, P_2	in		1.4		
5. Land slope, s	ft/ft		0.017		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr		0.263	+	= 0.263

Shallow concentrated flow		Segment ID	B452-C452		
7. Surface description (paved or unpaved)			Unpaved		
8. Flow length, L	ft		740		
9. Watercourse slope, s	ft/ft		0.012		
10. Average velocity, V (figure 3-1)	ft/s		1.8		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		0.114	+	= 0.114

Channel flow		Segment ID	C452-D452		
12. Cross sectional flow area, a	ft^2				
13. Wetted perimeter, p_w	ft				
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft				
15. Channel slope, s	ft/ft		0.010		
16. Manning's roughness coeff., n					
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s		3.0	1.0	
18. Flow length, L	ft		880	300	
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		0.081	+ 0.083	= 0.164

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) ..... hr 0.541

= 32.5 min.

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Tatum Blvd. By D.L.B. Date 2-9-90

Location Mockingbird Ln. to Shea Blvd. Checked ____ Date ____

Circle one: Present Developed

Circle one: (T_c) T_t through subarea Subbasin #410

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)		Segment ID	A410 - B410		
1. Surface description (table 3-1)			Fallow		
2. Manning's roughness coeff., n (table 3-1) ..			0.05		
3. Flow length, L (total L $\leq$ 300 ft)	ft		250		
4. Two-yr 24-hr rainfall, P_2	in		1.40		
5. Land slope, s	ft/ft		0.66		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr		0.053	+	= 0.053

Shallow concentrated flow		Segment ID	B410 - C410		
7. Surface description (paved or unpaved)			Unpaved		
8. Flow length, L	ft		320		
9. Watercourse slope, s	ft/ft		0.39		
10. Average velocity, V (figure 3-1)	ft/s		10.0		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		0.009	+	= 0.009

Channel flow		Segment ID	C410 - D410	D410 - 4010	
12. Cross sectional flow area, a	ft^2				
13. Wetted perimeter, p_w	ft				
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft				
15. Channel slope, s	ft/ft		0.12	0.018	
16. Manning's roughness coeff., n					
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s		12.0	8.0	
18. Flow length, L	ft		600	1880	
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		0.014	+ 0.065	= 0.079

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) ..... hr 0.141

≈ 8.5 min.

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Tatum Blvd. By D.L.B. Date 2-9-90

Location Mockingbird Ln. to Shea Blvd. Checked ____ Date ____

Circle one: Present Developed

Circle one: (T_c) T_t through subarea Subbasin #400

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)	Segment ID	A400 - F400		
1. Surface description (table 3-1)		Fallow		
2. Manning's roughness coeff., n (table 3-1) ..		0.05		
3. Flow length, L (total L ≤ 300 ft)	ft	255		
4. Two-yr 24-hr rainfall, P_2	in	1.4		
5. Land slope, s	ft/ft	0.56		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	0.062	+	= 0.062

Shallow concentrated flow	Segment ID	F400 - C400		
7. Surface description (paved or unpaved)		Unpaved		
8. Flow length, L	ft	255		
9. Watercourse slope, s	ft/ft	0.39		
10. Average velocity, V (figure 3-1)	ft/s	10.0		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.007	+	= 0.007

Channel flow	Segment ID	C400 - D400	D400 - 400
12. Cross sectional flow area, a	ft^2		
13. Wetted perimeter, p_w	ft		
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft		
15. Channel slope, s	ft/ft	0.085	0.018
16. Manning's roughness coeff., n			
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s	12.0	8.0
18. Flow length, L	ft	1780	1140
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.041	+ 0.040 = 0.081

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) ..... hr 0.150

≈ 9 min.

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	400	386.	.42	27.	7.	7.	.15		

*** NORMAL END OF HEC-1 ***

KAMINSKI HUBBARD engineering inc. • Surveying • Civil • Hydrology	Made by D.L.B.	Date 3-28-90	Job No. 011B
	Checked by	Date	Sheet No.
	For		

COMBINE SUB-BASINS # 400 & #410

1. Mountains D.A. = 18.03 + 22.16 = 40.19 Ac.
   CN = 95

2. Assume 80% of this RE-43 Contributes
   D.A. = (0.80)(23.21) = 18.57 Ac.

3. Assume 90% of this RE-43 Contributes
   D.A. = (0.90)(13.71) = 12.34 Ac.

4. Assume 85% of this RE-43 Contributes
   D.A. = (0.85)(28.95) = 24.61 Ac.

CN = 86

Total D.A. Contributing = 95.71 Ac. = 0.14955 mi.^{2}

$$\text{Weighted C.N. (1 Hr.)} = \frac{(86)(18.57 + 12.34 + 24.61) + (95)(40.19)}{95.71}$$

$$= \underline{\underline{89.8}}$$

$$\text{Weighted C.N. (24 Hr.)} = 83.0 + 0.8(84.4 - 83.0)$$

$$= \underline{\underline{84.1}}$$

APPENDIX C-2

DRAINAGE AREA NO. 2

* SUB-BASINS 421-423 & 431-432

KAMINSKI HUBBARD engineering inc. • Surveying • Civil • Hydrology	Made by D.L.B.	Date 3-16-90	Job No. D118
	Checked by	Date	Sheet No.
	For		

DRAINAGE CALCULATIONS FOR SUBBASIN NO. 422

(1) Zoning: 100% RE-43
Drainage Area = 9.64 Ac.
'C' Coefficient = 0.45
Time of Conc., t_c = 10 min.

Rational Eq. $Q = CIA$

Description	2 YR.	10 YR.	25 YR.	50 YR.	100 YR.
Intensity, in/hr	2.4	3.8	4.5	5.0	5.5
Q, CFS	10.4	16.5	19.5	21.7	23.9

DRAINAGE CALCULATIONS FOR SUBBASIN NO. 421

(1) Zoning: 100% RE-43
Drainage Area = 6.76 Ac.
'C' Coefficient = 0.45
Time of Conc., t_c = 10 min

Rational Eq.: $Q = CIA$

Description	2 YR.	10 YR.	25 YR.	50 YR.	100 YR.
Intensity, in/hr.	2.4	3.8	4.5	5.0	5.5
Q, CFS	7.3	11.6	13.7	15.2	16.7

KAMINSKI HUBBARD engineering inc. • Surveying • Civil • Hydrology	Made by D.L.B.	Date 3-16-90	Job No. 0118
	Checked by	Date	Sheet No.
	For		

DRAINAGE CALCULATIONS FOR SUBBASIN NO. 423

(1) Zoning : 49% RE-43 & 51% Hillside (over 10% sloping)

Drainage Area, A = 20.96 Ac.
Weighted 'C' Coefficient = 0.58
Time of Conc., t_c = 10 min.

Rational Eq. $Q = CIA$

Description	2YR.	10YR.	25YR.	50YR.	100YR.
Intensity, in/hr	2.4	3.8	4.5	5.0	5.5
Q, CFS	29.2	46.2	54.7	60.8	66.9

(2) Retention Basin Storage

① Surface Area = 19,800 ft^2 = 0.45455 Ac.
Avg. Depth = 3.0 ft

② Surface Area = 22,100 ft^2
Depth = 0.30 ft

∴ Avg. Volume = (19,800)(3.0) + (22,100)(0.30) = 66,030 ft^3
* From Collar, Williams & White Grading Plan, Vol. = 162,203 ft^3

(3) Retention Basin Storage vs. Peak Discharge (2hr duration) Using City of Phoenix Method

Required Capacity = 7200 Q (ft^3)

Description	2YR.	10YR.	25YR.	50YR.	100YR.
Intensity, in/hr	0.48	0.80	0.96	1.10	1.25
Q, CFS	5.8	9.7	11.7	13.4	15.2
Required Capacity (ft^3)	42,014	70,023	84,028	96,292	109,411

KAMINSKI HUBBARD engineering inc. • Surveying • Civil • Hydrology	Made by D.L.B.	Date 3-16-90	Job No. 0118
	Checked by	Date	Sheet No.
	For		

DRAINAGE CALCS. SUBBASIN 423 (CONTD)

(4) Retention Basin Storage vs. Peak Discharge (t_c)

$$\text{Volume } (ft^3) = Q_i \times 2.67 \times t_c \times 0.5 \times 60$$

Description	2 YR.	10 YR.	25 YR	50 YR.	100 YR.
Q, CFS	29.2	46.2	54.7	60.9	66.9
Volume, ft^3	23,399	37,006	43,815	48,701	53,587

KAMINSKI HUBBARD engineering inc. • Surveying • Civil • Hydrology	Made by D.L.B.	Date 3-16-90	Job No. 0118
	Checked by	Date	Sheet No.
	For		

DRAINAGE CALCULATIONS FOR SUBBASIN NO. 432

(1) Zoning: 100% RE-43
Drainage Area = 8.64 Ac.
'C' Coefficient = 0.45
Time of Conc., t_c = 10 min.

Rational Eq. $Q = CIA$

Description	2 YR.	10 YR.	25 YR.	50 YR.	100 YR.
Intensity, in/hr	2.4	3.8	4.5	5.0	5.5
Q, CFS	9.3	14.8	17.5	19.4	21.4

(2) Retention Basin Storage

Surface Area = 46,050 ft^2 = 1.05716 Ac
Avg. Depth = 3 ft

∴ Avg. Volume = (46,050)(3) = 138,150

From Collar, Williams & White Grading Plan:
Retention Vol. = 167,247 ft^3

(3) Retention Basin Storage vs. Peak Discharge (2 hr. Duration) Using City of Phoenix Method

Required Capacity = 7200 Q (ft^3)

Description	2 YR.	10 YR	25 YR	50 YR	100 YR.
Intensity, in/hr	0.48	0.80	0.96	1.10	1.25
Q, CFS	1.9	3.1	3.7	4.3	4.9
Volume, ft^3	13,437	22,395	26,874	30,793	34,992

KAMINSKI HUBBARD engineering inc. • Surveying • Civil • Hydrology	Made by D.L.B.	Date 3-16-90	Job No. 0118
	Checked by	Date	Sheet No.
	For		

DRAINAGE CALCS. FOR SUBBASIN NO. 432 (CONTD)

(4) Retention Basin Storage vs. Peak Discharge (t_c)

$$\text{Volume } (ft^3) = Q_i \times 2.67 \times t_c \times 0.5 \times 60$$

Description	2YR.	10YR.	25YR.	50YR.	100YR.
Q, CFS	9.3	14.8	17.5	19.4	21.4
Volume, ft^3	7,449	11,855	14,018	15,539	17,141

DRAINAGE CALCULATIONS FOR SUBBASIN NO. 431

(1) Zoning: 100% RE-43
Drainage Area = 6.79 Ac.
'C' Coefficient = 0.45
Time of Conc. = 10min.

Rational Eq.: $Q = CIA$

Description	2 YR	10 YR.	25 YR.	50 YR.	100 YR.
Intensity, in/hr	2.4	3.8	4.5	5.0	5.5
Q, CFS	7.3	11.6	13.7	15.3	16.8

KAMINSKI HUBBARD engineering inc. • Surveying • Civil • Hydrology	Made by D.L.B.	Date 3-1-90	Job No. 0118
	Checked by	Date	Sheet No.
	For		

SUBBASIN NO. 423

Total Drainage Area = 0.03455 mi.^{2} = 22.11 Ac.

a. Zoning: RE-43 CN(1hr.) = 86 C = 0.45
Drainage Area = 0.01794 mi.^{2} = 11.48 Ac.
Assume 90% Contributes
∴ Drainage Area = 0.01614 mi.^{2} = 10.33 Ac.

b. Zoning: Hillside (over 10% sloping) CN(1hr.) = ~~98~~ 95 C = 0.70
Drainage Area = 0.01661 mi.^{2} = 10.63 Ac.

Total Contributing Area = 0.03275 mi.^{2} = 20.96 Ac.

Weighted Curve No. & 'C' Coefficient

$$CN(1hr.) = \frac{(86)(0.01614) + \overset{95}{\cancel{(98)}}(0.01661)}{0.03275} = \cancel{92.1}\ 90.6$$

$$CN(24hr) = \overset{0.6}{\cancel{0.1}}(\overset{86.1}{\cancel{89.8}} - \overset{84.4}{\cancel{87.7}}) + \overset{84.4}{\cancel{87.7}} = \cancel{87.9}\ 85.4$$

$$C = \frac{(0.45)(0.01614) + (0.70)(0.01661)}{0.03275} = 0.58$$

SUBBASIN NO. 422

Total Drainage Area = 0.01673 mi.^{2} = 10.71 Ac.

Zoning: RE-43 CN(1hr) = 86 C = 0.45
Assume 90% Contributes
∴ Drainage Area = 0.01506 mi.^{2} = 9.64 Ac.

SUBBASIN NO. 421

Total Drainage Area = 0.01174 mi^2 = 7.52 Ac.

Zoning: RE-43 CN(1hr.) = 86 C = 0.45
Assumes 90% Contributes
∴ Drainage Area = 0.01057 mi.^{2} = 6.76 Ac.

KAMINSKI HUBBARD engineering inc. • Surveying • Civil • Hydrology	Made by D.L.B.	Date 3-1-90	Job No. 0118
	Checked by	Date	Sheet No.
	For		

SUBBASIN NO. 432

Total Drainage Area = 0.01499 mi.^{2} = 9.60 Ac.

Zoning: RE-43 CN(1hr) = 86 C = 0.45
Assumes 90% Contributes
∴ Drainage Area = 0.01349 mi.^{2} = 8.64 Ac.

SUBBASIN NO. 431

Total Drainage Area = 0.01178 mi.^{2} = 7.54 Ac.

Zoning: RE-43 CN(1hr) = 86 C = 0.45
Assume 90% Contributes
∴ Drainage Area = 0.01060 mi.^{2} = 6.79 Ac.

* The time of concentration for Sub-basin #423 was computed and is presented on the next page. The hydraulic path for Sub-basin #423 was longer than the paths for Sub-basins #421, #422, #431 & #432. Since the time of concentration for #423 was less than 10 minutes, it was also assumed that the time of concentration for Sub-basins #421, #422, #431 & #432 was less than 10 minutes.

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Tatum Blvd. By ____ Date 3-15-90

Location Mockingbird Lane to Shea Blvd. Checked ____ Date ____

Circle one: Present Developed

Circle one: (T_c) T_t through subarea Subbasin #423

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)		Segment ID	A423-B423		
1. Surface description (table 3-1)			Fallow		
2. Manning's roughness coeff., n (table 3-1) ..			0.05		
3. Flow length, L (total L $\leq$ 300 ft)	ft		300		
4. Two-yr 24-hr rainfall, P_2	in		1.4		
5. Land slope, s	ft/ft		0.45		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr		0.071	+	= 0.071

Shallow concentrated flow		Segment ID	B423-C423	C423-4230	
7. Surface description (paved or unpaved)			Unpaved	Unpaved	
8. Flow length, L	ft		480	960	
9. Watercourse slope, s	ft/ft		0.34	0.047	
10. Average velocity, V (figure 3-1)	ft/s		9.5	3.5	
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		0.014	+ 0.076	= 0.090

Channel flow		Segment ID			
12. Cross sectional flow area, a	ft^2				
13. Wetted perimeter, p_w	ft				
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft				
15. Channel slope, s	ft/ft				
16. Manning's roughness coeff., n					
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s				
18. Flow length, L	ft				
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr			+	=

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) ..... hr 0.161

= 9.66 min

Use t_c = 10 min

APPENDIX D-1

DRAINAGE AREA NO. 3

* HEC-1 OUTPUT

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID                  CITY OF PHOENIX PROJECT NO. P-886515
  2           ID                TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
  3           ID            KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 011B
  4           ID                    HEC-1 FILENAME :  11S-34.DAT
  5           ID                PRELIMINARY RUN - 2 YEAR - 24 HOUR STORM
  6           IT       5 07FEB90    1000     300 08FEB90    1000
  7           IO       5

  8           KK     443
  9           KM                      Subarea No. 443
 10           BA   .1987
 11           IN      30 07FEB90    1000
 12           PB    1.44
 13           PC    .000    .004    .008    .013    .018    .022    .026    .031    .035
 14           PC    .040    .044    .048    .053    .057    .062    .066    .071    .075
 15           PC    .080    .093    .107    .120    .140    .170    .500    .830    .860
 16           PC    .880    .893    .907    .920    .924    .928    .933    .937    .942
 17           PC    .947    .951    .956    .960    .964    .969    .973    .978    .982
 18           PC    .987    .991    .995   1.000
 19           LS            86.6
 20           UD    .174

 21           KK    442R
 22           KM                      Route Hydrograph 443 thru 442
 23           RL            .005
 24           RS      31    FLOW      -1     0.3
 25           RC     .03     .03     .03    1550    .015
 26           RX      10      12      14      62      72     112     114     116
 27           RY       8       7       7       1       1       9       9      10

 28           KK     442
 29           KM                      Subarea No. 442
 30           BA   .0449
 31           LS            83.7
 32           UD    .149

 33           KK    442C
 34           KM                      Combine Hydrographs 443 & 442
 35           HC       2

 36           KK    441R
 37           KM                      Route Hydrographs 443\442 thru 441
 38           RL            .03
 39           RS      24    FLOW      -1     0.3
 40           RC     .03     .03     .03    1200    .011
 41           RX      10      12      14      24      42      52      54      56
 42           RY       8       7       7       2       2       7       7       8

 43           KK     441
 44           KM                      Subarea No. 441
 45           BA   .0108
 46           LS            78.8
 47           UD    .100
```

```
****************************************
*                                      *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*            FEBRUARY 1981             *
*          REVISED 01 JUN 88           *
*                                      *
* RUN DATE  03/28/1990  TIME  10:14:06 *
*                                      *
****************************************
```

```
****************************************
*                                      *
*   U.S. ARMY CORPS OF ENGINEERS       *
*  THE HYDROLOGIC ENGINEERING CENTER   *
*          609 SECOND STREET           *
*       DAVIS, CALIFORNIA 95616        *
*           (916) 551-1748             *
*                                      *
****************************************
```

CITY OF PHOENIX PROJECT NO. P-886515
TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 0118
HEC-1 FILENAME : 118-34.DAT
PRELIMINARY RUN - 2 YEAR - 24 HOUR STORM

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

  IT         HYDROGRAPH TIME DATA
                   NMIN          5  MINUTES IN COMPUTATION INTERVAL
                  IDATE     7FEB90  STARTING DATE
                  ITIME       1000  STARTING TIME
                     NQ        289  NUMBER OF HYDROGRAPH ORDINATES
                 NDDATE     8FEB90  ENDING DATE
                 NDTIME       1000  ENDING TIME
                  ICENT         19  CENTURY MARK

            COMPUTATION INTERVAL     .08 HOURS
                 TOTAL TIME BASE   24.00 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	443	302.	20.00	49.	15.	15.	.20		
ROUTED TO	442R	296.	20.08	49.	15.	15.	.20	2.91	20.08
HYDROGRAPH AT	442	67.	20.00	10.	3.	3.	.04		
2 COMBINED AT	442C	361.	20.00	59.	18.	18.	.24		
ROUTED TO	441R	354.	20.08	57.	18.	18.	.24	4.16	20.08
HYDROGRAPH AT	441	15.	20.00	2.	1.	1.	.01		
2 COMBINED AT	441C	365.	20.08	59.	18.	18.	.25		

*** NORMAL END OF HEC-1 ***

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID                 CITY OF PHOENIX PROJECT NO. P-886515
  2           ID              TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
  3           ID           KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 0118
  4           ID                 HEC-1 FILENAME :  118-33.DAT
  5           ID              PRELIMINARY RUN - 10 YEAR - 24 HOUR STORM
  6           IT       5 07FEB90    1000     300 08FEB90    1000
  7           IO       5

  8           KK     443
  9           KM                     Subarea No. 443
 10           BA   .1987
 11           IN      30 07FEB90    1000
 12           PB    2.53
 13           PC    .000    .004    .008    .013    .018    .022    .026    .031    .035
 14           PC    .040    .044    .048    .053    .057    .062    .066    .071    .075
 15           PC    .080    .093    .107    .120    .140    .170    .500    .830    .860
 16           PC    .880    .893    .907    .920    .924    .928    .933    .937    .942
 17           PC    .947    .951    .956    .960    .964    .969    .973    .978    .982
 18           PC    .987    .991    .995   1.000
 19           LS            86.6
 20           UD    .174

 21           KK    442R
 22           KM                     Route Hydrograph 443 thru 442
 23           RL            .015
 24           RS      31    FLOW      -1     0.3
 25           RC     .03     .03     .03    1550    .015
 26           RX      10      12      14      62      72     112     114     116
 27           RY       8       7       7       1       1       9       9      10

 28           KK     442
 29           KM                     Subarea No. 442
 30           BA   .0449
 31           LS            83.7
 32           UD    .149

 33           KK    442C
 34           KM                     Combine Hydrographs 443 & 442
 35           HC       2

 36           KK    441R
 37           KM                     Route Hydrographs 443\442 thru 441
 38           RL            .015
 39           RS      24    FLOW      -1     0.3
 40           RC     .03     .03     .03    1200    .011
 41           RX      10      12      14      24      42      52      54      56
 42           RY       9       7       7       2       2       7       7       8

 43           KK     441
 44           KM                     Subarea No. 441
 45           BA   .0108
 46           LS            78.8
 47           UD    .100
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  48          KK    441C
  49          KM                    Combine Hydrographs 443\442 & 441
  50          HC      2
  51          ZZ
```

```
:*************************************
:                                   *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
:          FEBRUARY 1981            *
:        REVISED 01 JUN 98          *
*                                   *
* RUN DATE  03/28/1990  TIME  10:07:34 *
:                                   *
*************************************
```

```
*************************************
*                                   *
*   U.S. ARMY CORPS OF ENGINEERS    *
* THE HYDROLOGIC ENGINEERING CENTER *
*        609 SECOND STREET          *
*      DAVIS, CALIFORNIA 95616      *
*         (916) 551-1748            *
*                                   *
*************************************
```

```
                    CITY OF PHOENIX PROJECT NO. P-886515
                  TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
               KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 0118
                        HEC-1 FILENAME :  118-33.DAT
                  PRELIMINARY RUN - 10 YEAR - 24 HOUR STORM

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

   IT        HYDROGRAPH TIME DATA
                   NMIN          5  MINUTES IN COMPUTATION INTERVAL
                  IDATE     7FEB90  STARTING DATE
                  ITIME       1000  STARTING TIME
                     NQ        289  NUMBER OF HYDROGRAPH ORDINATES
                 NDDATE     8FEB90  ENDING DATE
                 NDTIME       1000  ENDING TIME
                 ICENT         19  CENTURY MARK

            COMPUTATION INTERVAL     .08 HOURS
                 TOTAL TIME BASE   24.00 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	443	566.	20.00	96.	31.	31.	.20		
ROUTED TO	442R	554.	20.00	94.	31.	31.	.20	3.55	20.00
HYDROGRAPH AT	442	129.	20.00	21.	7.	7.	.04		
2 COMBINED AT	442C	682.	20.00	115.	38.	38.	.24		
ROUTED TO	441R	669.	20.00	113.	37.	37.	.24	5.07	20.00
HYDROGRAPH AT	441	31.	20.00	5.	1.	1.	.01		
2 COMBINED AT	441C	691.	20.00	118.	38.	38.	.25		

*** NORMAL END OF HEC-1 ***

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID                 CITY OF PHOENIX PROJECT NO. P-886515
  2           ID              TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
  3           ID           KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 0118
  4           ID                     HEC-1 FILENAME :  118-32.DAT
  5           ID              PRELIMINARY RUN - 25 YEAR - 24 HOUR STORM
  6           IT       5 07FEB90    1000     300 08FEB90    1000
  7           IO       5

  8           KK     443
  9           KM                     Subarea No. 443
 10           BA   .1987
 11           IN      30 07FEB90    1000
 12           PB    3.12
 13           PC    .000    .004    .008    .013    .018    .022    .026    .031    .035
 14           PC    .040    .044    .048    .053    .057    .062    .066    .071    .075
 15           PC    .080    .093    .107    .120    .140    .170    .500    .830    .860
 16           PC    .880    .893    .907    .920    .924    .928    .933    .937    .942
 17           PC    .947    .951    .956    .960    .964    .969    .973    .978    .982
 18           PC    .987    .991    .995   1.000
 19           LS            86.6
 20           UD    .174

 21           KK    442R
 22           KM                     Route Hydrograph 443 thru 442
 23           RL            .01
 24           RS      31    FLOW      -1     0.3
 25           RC     .03     .03     .03    1550    .015
 26           RX      10      12      14      62      72     112     114     116
 27           RY       8       7       7       1       1       9       9      10

 28           KK     442
 29           KM                     Subarea No. 442
 30           BA   .0449
 31           LS            83.7
 32           UD    .149

 33           KK    442C
 34           KM                     Combine Hydrographs 443 & 442
 35           HC       2

 36           KK    441R
 37           KM                     Route Hydrographs 443\442 thru 441
 38           RL            .01
 39           RS      24    FLOW      -1     0.3
 40           RC     .03     .03     .03    1200    .011
 41           RX      10      12      14      24      42      52      54      56
 42           RY       8       7       7       2       2       7       7       8

 43           KK     441
 44           KM                     Subarea No. 441
 45           BA   .0188
 46           LS            78.8
 47           UD    .100
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  48          KK    441C
  49          KM                    Combine Hydrographs 443\442 & 441
  50          HC      2
  51          ZZ
```

```
*************************************
*                                   *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*            FEBRUARY 1981          *
*          REVISED 01 JUN 88        *
*                                   *
* RUN DATE  03/28/1990  TIME  10:02:56 *
*                                   *
*************************************
```

```
*************************************
*                                   *
*   U.S. ARMY CORPS OF ENGINEERS    *
* THE HYDROLOGIC ENGINEERING CENTER *
*         609 SECOND STREET         *
*      DAVIS, CALIFORNIA 95616      *
*          (916) 551-1748           *
*                                   *
*************************************
```

CITY OF PHOENIX PROJECT NO. P-886515
TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 0118
HEC-1 FILENAME : 118-32.DAT
PRELIMINARY RUN - 25 YEAR - 24 HOUR STORM

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

   IT         HYDROGRAPH TIME DATA
                     NMIN          5  MINUTES IN COMPUTATION INTERVAL
                    IDATE     7FEB90  STARTING DATE
                    ITIME       1000  STARTING TIME
                       NQ        289  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE     8FEB90  ENDING DATE
                   NDTIME       1000  ENDING TIME
                    ICENT         19  CENTURY MARK

              COMPUTATION INTERVAL     .08 HOURS
                   TOTAL TIME BASE   24.00 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	443	707.	20.00	121.	40.	40.	.20		
ROUTED TO	442R	693.	20.00	119.	40.	40.	.20	3.84	20.00
HYDROGRAPH AT	442	162.	20.00	27.	9.	9.	.04		
2 COMBINED AT	442C	854.	20.00	146.	49.	49.	.24		
ROUTED TO	441R	842.	20.08	144.	48.	48.	.24	5.47	20.08
HYDROGRAPH AT	441	39.	20.00	6.	2.	2.	.01		
2 COMBINED AT	441C	870.	20.08	150.	50.	50.	.25		

*** NORMAL END OF HEC-1 ***

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID                 CITY OF PHOENIX PROJECT NO. P-886515
  2           ID              TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
  3           ID           KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 0118
  4           ID                     HEC-1 FILENAME :  118-31.DAT
  5           ID              PRELIMINARY RUN - 50 YEAR - 24 HOUR STORM
  6           IT       5 07FEB90    1000     300 08FEB90    1000
  7           IO       5

  8           KK     443
  9           KM                     Subarea No. 443
 10           BA   .1987
 11           IN      30 07FEB90    1000
 12           PB    3.57
 13           PC    .000    .004    .008    .013    .018    .022    .026    .031    .035
 14           PC    .040    .044    .048    .053    .057    .062    .066    .071    .075
 15           PC    .080    .093    .107    .120    .140    .170    .500    .830    .860
 16           PC    .880    .893    .907    .920    .924    .928    .933    .937    .942
 17           PC    .947    .951    .956    .960    .964    .969    .973    .978    .982
 18           PC    .987    .991    .995   1.000
 19           LS            86.6
 20           UD    .174

 21           KK    442R
 22           KM                     Route Hydrograph 443 thru 442
 23           RL            .01
 24           RS      31    FLOW      -1     0.3
 25           RC     .03     .03     .03    1550    .015
 26           RX      10      12      14      62      72     112     114     116
 27           RY       8       7       7       1       1       9       9      10

 28           KK     442
 29           KM                     Subarea No. 442
 30           BA   .0449
 31           LS            83.7
 32           UD    .149

 33           KK    442C
 34           KM                     Combine Hydrographs 443 & 442
 35           HC       2

 36           KK    441R
 37           KM                     Route Hydrographs 443\442 thru 441
 38           RL            .01
 39           RS      24    FLOW      -1     0.3
 40           RC     .03     .03     .03    1200    .011
 41           RX      10      12      14      24      42      52      54      56
 42           RY       8       7       7       2       2       7       7       8

 43           KK     441
 44           KM                     Subarea No. 441
 45           BA   .0108
 46           LS            78.8
 47           UD    .100
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  48          KK    441C
  49          KM                    Combine Hydrographs 443\442 & 441
  50          HC      2
  51          ZZ
```

```
*************************************
*                                   *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1) *
*           FEBRUARY 1981           *
*         REVISED 01 JUN 88         *
*                                   *
* RUN DATE  03/28/1990  TIME  09:58:20 *
*                                   *
*************************************
```

```
*************************************
*                                   *
*   U.S. ARMY CORPS OF ENGINEERS    *
* THE HYDROLOGIC ENGINEERING CENTER *
*         609 SECOND STREET         *
*      DAVIS, CALIFORNIA 95616      *
*          (916) 551-1748           *
*                                   *
*************************************
```

CITY OF PHOENIX PROJECT NO. P-886515
TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 0118
HEC-1 FILENAME : 118-31.DAT
PRELIMINARY RUN - 50 YEAR - 24 HOUR STORM

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

    IT         HYDROGRAPH TIME DATA
                     NMIN          5  MINUTES IN COMPUTATION INTERVAL
                    IDATE     7FEB90  STARTING DATE
                    ITIME       1000  STARTING TIME
                       NQ        289  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE     8FEB90  ENDING DATE
                   NDTIME       1000  ENDING TIME
                    ICENT         19  CENTURY MARK

              COMPUTATION INTERVAL     .08 HOURS
                   TOTAL TIME BASE   24.00 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	443	814.	20.00	140.	47.	47.	.20		
ROUTED TO	442R	800.	20.00	138.	47.	47.	.20	4.01	20.00
HYDROGRAPH AT	442	187.	20.00	31.	10.	10.	.04		
2 COMBINED AT	442C	987.	20.00	169.	57.	57.	.24		
ROUTED TO	441R	968.	20.08	167.	57.	57.	.24	5.75	20.08
HYDROGRAPH AT	441	45.	20.00	7.	2.	2.	.01		
2 COMBINED AT	441C	1001.	20.08	174.	59.	59.	.25		

*** NORMAL END OF HEC-1 ***

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID                 CITY OF PHOENIX PROJECT NO. P-886515
  2           ID              TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
  3           ID           KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 0118
  4           ID                     HEC-1 FILENAME :  118-30.DAT
  5           ID              PRELIMINARY RUN - 100 YEAR - 24 HOUR STORM
  6           IT      5 07FEB90    1000     300 08FEB90    1000
  7           IO      5

  8           KK    443
  9           KM                    Subarea No. 443
 10           BA   .1987
 11           IN     30 07FEB90    1000
 12           PB   4.04
 13           PC   .000    .004    .008    .013    .018    .022    .026    .031    .035
 14           PC   .040    .044    .048    .053    .057    .062    .066    .071    .075
 15           PC   .080    .093    .107    .120    .140    .170    .500    .830    .860
 16           PC   .880    .893    .907    .920    .924    .928    .933    .937    .942
 17           PC   .947    .951    .956    .960    .964    .969    .973    .978    .982
 18           PC   .987    .991    .995   1.000
 19           LS           86.6
 20           UD   .174

 21           KK    442R
 22           KM                    Route Hydrograph 443 thru 442
 23           RL           .01
 24           RS     31    FLOW      -1     0.3
 25           RC    .03     .03     .03    1550    .015
 26           RX     10      12      14      62      72     112     114     116
 27           RY      8       7       7       1       1       9       9      10

 28           KK    442
 29           KM                    Subarea No. 442
 30           BA   .0449
 31           LS           83.7
 32           UD   .149

 33           KK    442C
 34           KM                    Combine Hydrographs 443 & 442
 35           HC      2

 36           KK    441R
 37           KM                    Route Hydrographs 443\442 thru 441
 38           RL           .01
 39           RS     24    FLOW      -1     0.3
 40           RC    .03     .03     .03    1200    .011
 41           RX     10      12      14      24      42      52      54      56
 42           RY      8       7       7       2       2       7       7       8

 43           KK    441
 44           KM                    Subarea No. 441
 45           BA   .0108
 46           LS           78.8
 47           UD   .100
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  48          KK    441C
  49          KM                    Combine Hydrographs 443\442 & 441
  50          HC      2
  51          ZZ
```

```
*************************************
*                                   *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1) *
*           FEBRUARY 1981           *
*         REVISED 01 JUN 88         *
*                                   *
* RUN DATE  03/28/1990  TIME  09:51:56 *
*                                   *
*************************************
```

```
*************************************
*                                   *
*   U.S. ARMY CORPS OF ENGINEERS    *
* THE HYDROLOGIC ENGINEERING CENTER *
*        609 SECOND STREET          *
*      DAVIS, CALIFORNIA 95616      *
*         (916) 551-1748            *
*                                   *
*************************************
```

```
                    CITY OF PHOENIX PROJECT NO. P-686515
                  TATUM BLVD. - MOCKINGBIRD LANE TO SHEA BLVD.
               KAMINSKI - HUBBARD ENGINEERING, INC. - JOB NO. 0118
                        HEC-1 FILENAME :  118-30.DAT
                  PRELIMINARY RUN - 100 YEAR - 24 HOUR STORM

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

  IT         HYDROGRAPH TIME DATA
                    NMIN          5  MINUTES IN COMPUTATION INTERVAL
                   IDATE     7FEB90  STARTING DATE
                   ITIME       1000  STARTING TIME
                      NQ        289  NUMBER OF HYDROGRAPH ORDINATES
                  NDDATE     8FEB90  ENDING DATE
                  NDTIME       1000  ENDING TIME
                   ICENT         19  CENTURY MARK

             COMPUTATION INTERVAL     .08 HOURS
                  TOTAL TIME BASE   24.00 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	443	926.	20.00	159.	55.	55.	.20		
ROUTED TO	442R	908.	20.00	158.	54.	54.	.20	4.19	20.00
HYDROGRAPH AT	442	213.	20.00	36.	12.	12.	.04		
2 COMBINED AT	442C	1120.	20.00	193.	66.	66.	.24		
ROUTED TO	441R	1099.	20.08	191.	65.	65.	.24	6.01	20.08
HYDROGRAPH AT	441	52.	20.00	8.	3.	3.	.01		
2 COMBINED AT	441C	1141.	20.00	199.	68.	68.	.25		

*** NORMAL END OF HEC-1 ***

APPENDIX D-2

DRAINAGE AREA NO. 3

* DESIGN CALCULATIONS

KAMINSKI HUBBARD engineering inc. • Surveying • Civil • Hydrology	Made by D.L.B.	Date 2-28-90	Job No. 0113
	Checked by	Date	Sheet No.
	For		

SUBBASIN NO. 443

Total Drainage Area = 0.20781 mi.^{2} = 132.99 Ac.

a. Zoning: RE-43 CN(1hr.) = 86 C = 0.45
Drainage Area = 0.09074 mi.^{2} = 58.07 Ac.
Assume 90% Contributes
∴ Drainage Area = 0.08166 mi.^{2} = 52.26 Ac.

b. Zoning: Hillside (over 10% Sloping) CN(1hr) = ~~98~~ 95 C = 0.70
Drainage Area = 0.11707 mi.^{2} = 74.92 Ac.

Weighted Curve No.

$$CN(1hr) = \frac{(86)(0.08166) + (\cancel{98}\ 95)(0.11707)}{0.19873} = \cancel{93.1}\ 91.3$$

$$CN(24hr) = \cancel{0.7}\ 0.3\,(\cancel{90.6}\ 87.7 - \cancel{89.8}\ 86.1) + \cancel{89.8}\ 86.1 = \cancel{89.9}\ 86.6$$

Weighted 'C' Coefficient

$$C = \frac{(0.45)(0.08166) + (0.70)(0.11707)}{0.19873} = 0.60$$

Total Contributing Area = 0.19873 mi.^{2} = 127.18 Ac.

SUBBASIN NO. 442

Total Drainage Area = 0.04788 mi.^{2} = 30.64 Ac.

a. Zoning: RE-43 CN(1hr) = 86 C = 0.45
Drainage Area = 0.03022 mi.^{2} = 19.34 Ac
Assume 90% Contributes
∴ Drainage Area = 0.02720 mi.^{2} = 17.40 Ac.

b. Zoning: Hillside (over 10% Sloping) CN(1hr) = ~~98~~ 95 C = 0.70
Drainage Area = 0.01766 mi.^{2} = 11.30 Ac.

Weighted Curve No. & 'C' Coefficient

$$CN(1hr) = \frac{(86)(0.02720) + (\cancel{98}\ 95)(0.01766)}{0.04486} = \cancel{90.7}\ 89.5$$

$$CN(24hr) = \cancel{0.7}\ 0.5\,(\cancel{86.1}\ 84.4 - \cancel{84.4}\ 83.0) + \cancel{84.4}\ 83.0 = \cancel{85.6}\ 83.7$$

$$C = \frac{(0.45)(0.02720) + (0.70)(0.01766)}{0.04486} = 0.55$$

Total Contributing Area = 0.04486 mi.^{2} = 28.70 Ac

KAMINSKI HUBBARD engineering inc. • Surveying • Civil • Hydrology	Made by D.L.B.	Date 3-1-90	Job No. 0118
	Checked by	Date	Sheet No.
	For		

SUBBASIN NO. 441

Total Drainage Area = 0.01195 mi.² = 7.65 Ac.
CN(24hr) = 78.8
Zoning: RE-43 CN(1hr) = 86 C = 0.45
Assume 90% Contributes
∴ Drainage Area = 0.01076 mi.² = 6.88 Ac.

SUBBASIN NO. 453

Total Drainage Area = 0.01251 mi.² = 8.01 Ac.
CN(24hr) = 78.8
Zoning: RE-43 CN(1hr) = 86 C = 0.45
Assume 90% Contributes
∴ Drainage Area = 0.01126 mi.² = 7.21 Ac.

SUBBASIN NO. 452

Total Drainage Area = 0.04641 mi.² = 29.70 Ac.
CN(24hr) = 78.8
Zoning: RE-43 CN(1hr.) = 86 C = 0.45
Assume 90% Contributes
∴ Drainage Area = 0.04177 mi.² = 26.73 Ac.

SUBBASIN NO. 451

Total Drainage Area = 0.02476 mi.² = 15.85 Ac.
CN(24hr) = 78.8
Zoning: RE-43 CN(1hr.) = 86 C = 0.45
Assume 90% Contributes
∴ Drainage Area = 0.02229 mi.² = 14.26 Ac.

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Tatum Blvd. By ____ Date 3-15-90

Location Mockingbird Lane to Shea Blvd. Checked ____ Date ____

Circle one: Present Developed

Circle one: (T_c) T_t through subarea Subbasin #441

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only) Segment ID

1. Surface description (table 3-1) .....
2. Manning's roughness coeff., n (table 3-1) ..
3. Flow length, L (total L $\leq$ 300 ft) ..... ft
4. Two-yr 24-hr rainfall, P_2 ..... in
5. Land slope, s ..... ft/ft
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t ..... hr

Shallow concentrated flow Segment ID

7. Surface description (paved or unpaved) .....
8. Flow length, L ..... ft
9. Watercourse slope, s ..... ft/ft
10. Average velocity, V (figure 3-1) ..... ft/s
11. $T_t = \frac{L}{3600\ V}$ Compute T_t ..... hr

Channel flow Segment ID

12. Cross sectional flow area, a ..... ft^2
13. Wetted perimeter, p_w ..... ft
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ..... ft
15. Channel slope, s ..... ft/ft
16. Manning's roughness coeff., n .....
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V ..... ft/s
18. Flow length, L ..... ft
19. $T_t = \frac{L}{3600\ V}$ Compute T_t ..... hr
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) ..... hr

< 10min.

Use 10min

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Tatum Blvd. By D.L.B. Date 3-15-90

Location Mockingbird Lane to Shea Blvd. Checked _____ Date _____

Circle one: Present Developed

Circle one: (T_c) T_t through subarea Subbasin #442

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)		Segment ID	A442-B442		
1. Surface description (table 3-1)			Fallow		
2. Manning's roughness coeff., n (table 3-1) ..			0.05		
3. Flow length, L (total L ≤ 300 ft)	ft		300		
4. Two-yr 24-hr rainfall, P_2	in		1.40		
5. Land slope, s	ft/ft		0.42		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr		0.073	+	= 0.073

Shallow concentrated flow		Segment ID	B442-C442		
7. Surface description (paved or unpaved)			Unpaved		
8. Flow length, L	ft		680		
9. Watercourse slope, s	ft/ft		0.23		
10. Average velocity, V (figure 3-1)	ft/s		7.8		
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		0.024	+	= 0.024

Channel flow		Segment ID	C442-D442	D442-4420	
12. Cross sectional flow area, a	ft^2				
13. Wetted perimeter, p_w	ft				
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft				
15. Channel slope, s	ft/ft		0.015	0.012	
16. Manning's roughness coeff., n					
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s		4.5	3.2	
18. Flow length, L	ft		1060	1000	
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		0.065	+ 0.087	= 0.152

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) ..... hr 0.249

= 14.9 min.

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project Tatum Blvd. By D.L.B. Date 3-1-90

Location Mockingbird Lane to Shea Blvd. Checked ____ Date ____

Circle one: Present Developed

Circle one: (T_c) T_t through subarea Subbasin # 443

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)	Segment ID	A443-B443		
1. Surface description (table 3-1)		Fallow		
2. Manning's roughness coeff., n (table 3-1) ..		0.05		
3. Flow length, L (total L ≤ 300 ft)	ft	200		
4. Two-yr 24-hr rainfall, P_2	in	1.40		
5. Land slope, s	ft/ft	0.51		
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr	0.049	+	= 0.049

Shallow concentrated flow	Segment ID	B443-C443	C443-D443	
7. Surface description (paved or unpaved)		Unpaved	Unpaved	
8. Flow length, L	ft	380	1340	
9. Watercourse slope, s	ft/ft	0.54	0.16	
10. Average velocity, V (figure 3-1)	ft/s	12.0	6.5	
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.009	+ 0.057	= 0.066

Channel flow	Segment ID	D443-4430		
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, p_w	ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft			
15. Channel slope, s	ft/ft	0.014		
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s	3.5		
18. Flow length, L	ft	2200		
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr	0.175	+	= 0.175

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) ..... hr 0.29

= 17.4 min

PROJECT: Tatum Blvd. Mockingbird Lane to Chea Blvd.

STATION: _____

SHEET _____ OF _____

CULVERT DESIGN FORM

DESIGNER / DATE: D.L.B. / 2-22-90

REVIEWER / DATE: _____ / _____

HYDROLOGICAL DATA

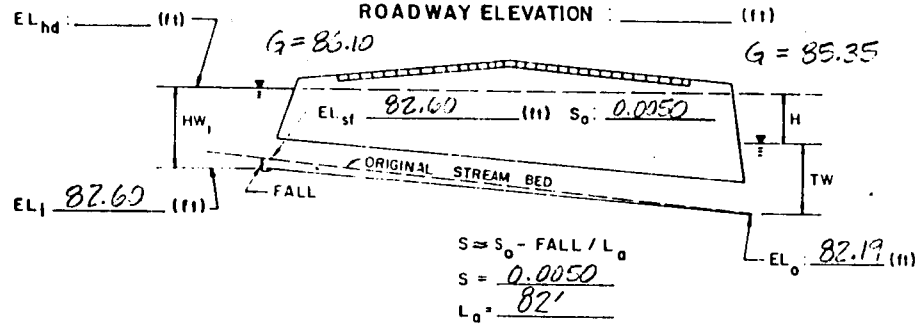
SEE ADD'L SHTS.

- ☐ METHOD: HEC-1
- ☐ DRAINAGE AREA: 41 Ac. ☐ STREAM SLOPE: _____
- ☐ CHANNEL SHAPE: _____
- ☐ ROUTING: _____ ☐ OTHER: _____

DESIGN FLOWS/TAILWATER

R.I. (YEARS)	FLOW (cfs)	TW (ft)
50	108	
100	130	

ROADWAY ELEVATION: _____ (ft)



$S = S_o - FALL / L_a$

$S = 0.0050$

$L_a = 82'$

CULVERT DESCRIPTION: MATERIAL - SHAPE - SIZE - ENTRANCE	TOTAL FLOW Q (cfs)	FLOW PER BARREL Q/N (1)	HEADWATER CALCULATIONS: INLET CONTROL HW_i/D (2)	HW_i	FALL (3)	EL_hi (4)	OUTLET CONTROL TW (5)	d_c	(d_c+D)/2	h_o (6)	k_e	H (7)	EL_ho (8)	CONTROL HEADWATER ELEVATION	OUTLET VELOCITY	COMMENTS
6 - 36" x 22" C.M.P.A. Hdwl.	108	18	1.0	1.83	–	84.43	1.83	1.09	1.46	1.83	0.5	1.22	85.24	85.24	4.1	
6 - 36" x 22" C.M.P.A. Hdwl.	141	23.5	1.28	2.35	–	84.95	1.83	1.27	1.55	1.83	0.5	2.08	86.10	86.10	5.3	Peak Q for Max. H
" " "	150	25	1.35	2.48	–	85.08		1.32	1.58	1.58	0.5	2.33	86.10	86.10	5.7	Assume $h_o = \frac{d_c+D}{2}$

TECHNICAL FOOTNOTES:

(1) USE Q/NB FOR BOX CULVERTS

(2) $HW_i/D = HW/D$ OR HW_i/D FROM DESIGN CHARTS

(3) $FALL = HW_i - (EL_{hd} - EL_{sf})$; FALL IS ZERO FOR CULVERTS ON GRADE

(4) $EL_{hi} = HW_i + EL_i$ (INVERT OF INLET CONTROL SECTION)

(5) TW BASED ON DOWN STREAM CONTROL OR FLOW DEPTH IN CHANNEL.

(6) h_o = TW or $(d_c + D/2)$ (WHICHEVER IS GREATER)

(7) $H = \left[1 + k_e + (29n^2 L)/R^{1.33}\right] V^2/2g$

(8) $EL_{ho} = EL_o + H + h_o$

SUBSCRIPT DEFINITIONS:

a. APPROXIMATE
f. CULVERT FACE
hd. DESIGN HEADWATER
hi. HEADWATER IN INLET CONTROL
ho HEADWATER IN OUTLET CONTROL
i INLET CONTROL SECTION
o. OUTLET
sf. STREAMBED AT CULVERT FACE
tw TAILWATER

COMMENTS / DISCUSSION:

Exist. 6-36" x 22" C.M.P.A. will convey 150 CFS without overtopping Hwy. C.O.R., provided that $h_o = \frac{d_c+D}{2}$

CULVERT BARREL SELECTED:

SIZE: _____

SHAPE: _____

MATERIAL: _____

ENTRANCE: _____

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	Checked by	Date	Sheet No.
	For		

Outlet Velocity of 6 - 36" x 22" C.M.P.A.

a) $Q = 18$ CFS / Barrel $\quad n = 0.024 \quad S = 0.0050$ '/ft

$K = 185$ (Table VI)

$Q_{full} = K S^{1/2} = 185 (0.0050)^{1/2} = 13.1$ CFS < 18 CFS

$\therefore V = Q/A = 18/4.4 = 4.1$ fps

b) $Q = 23.5$ CFS / barrel $\quad n = 0.024 \quad S = 0.0050$ '/ft

$Q_{full} = 13.1$ CFS < 23.5 CFS

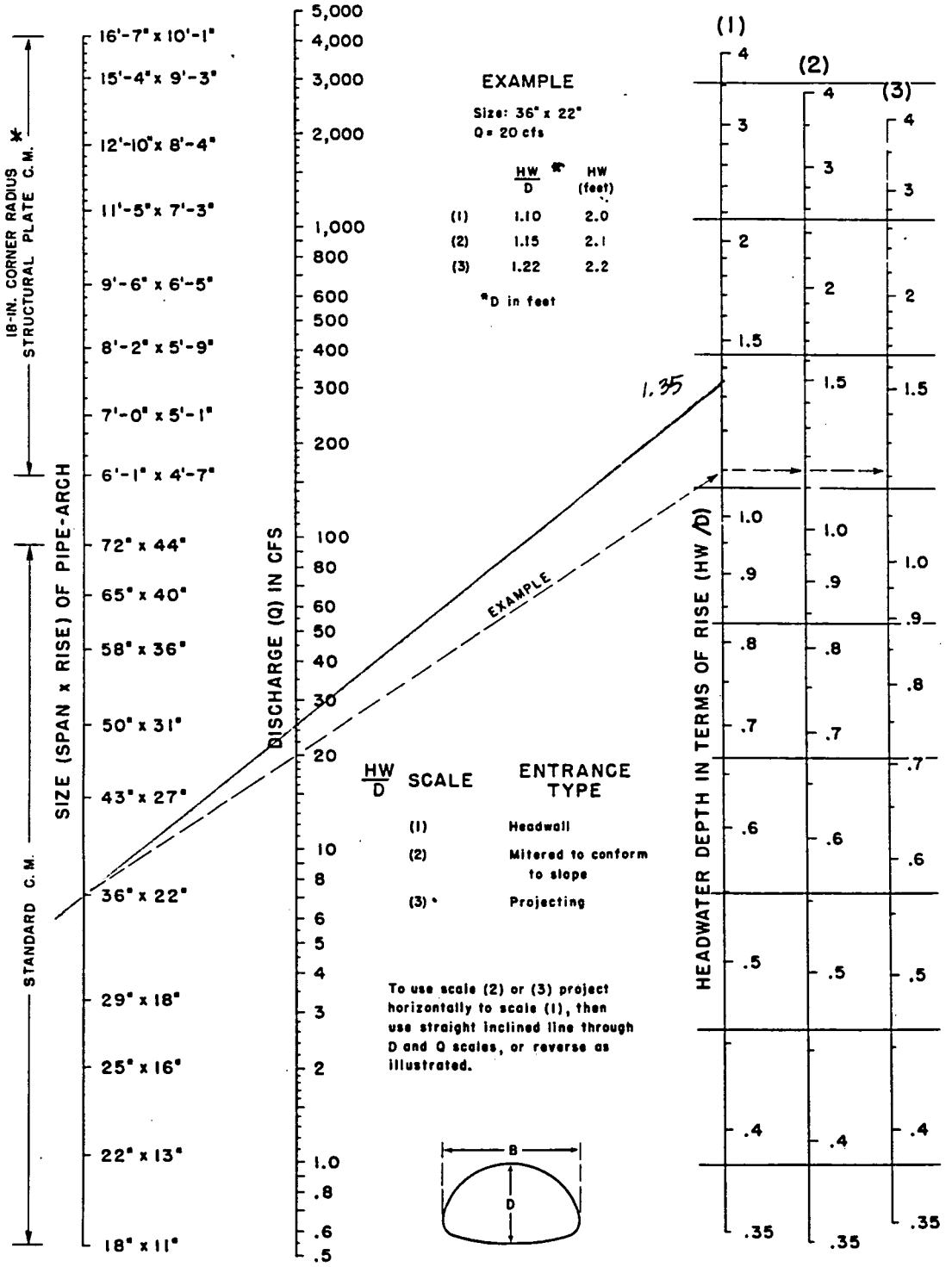
$\therefore V = Q/A = 23.5/4.4 = 5.3$ fps

c) $Q = 25$ CFS / barrel $\quad n = 0.024 \quad S = 0.0050$ '/ft

$Q_{full} = 13.1$ CFS < 25 CFS

$\therefore V = Q/A = 25/4.4 = 5.7$ fps

CHART 34

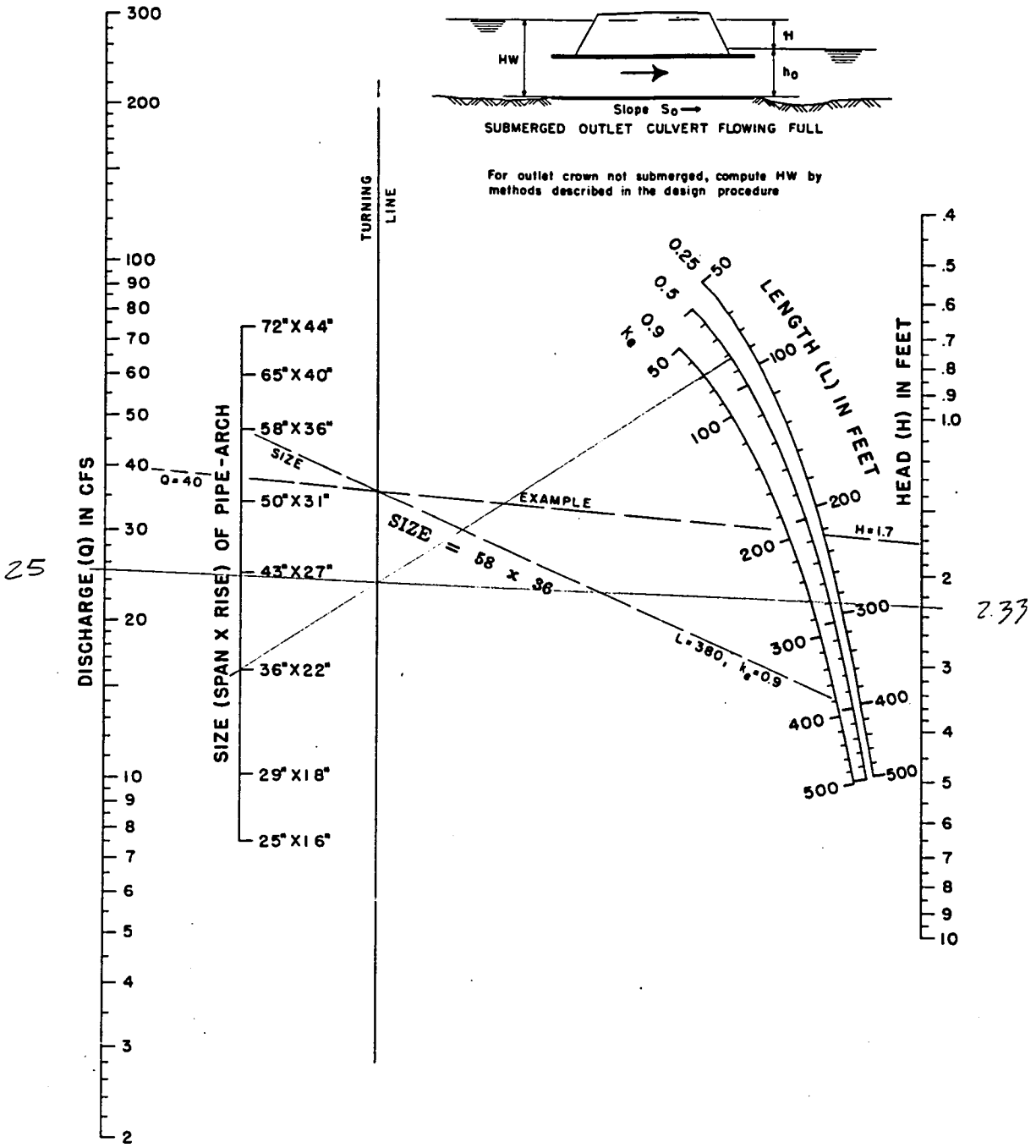


*ADDITIONAL SIZES NOT DIMENSIONED ARE LISTED IN FABRICATOR'S CATALOG

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR C. M. PIPE-ARCH CULVERTS WITH INLET CONTROL

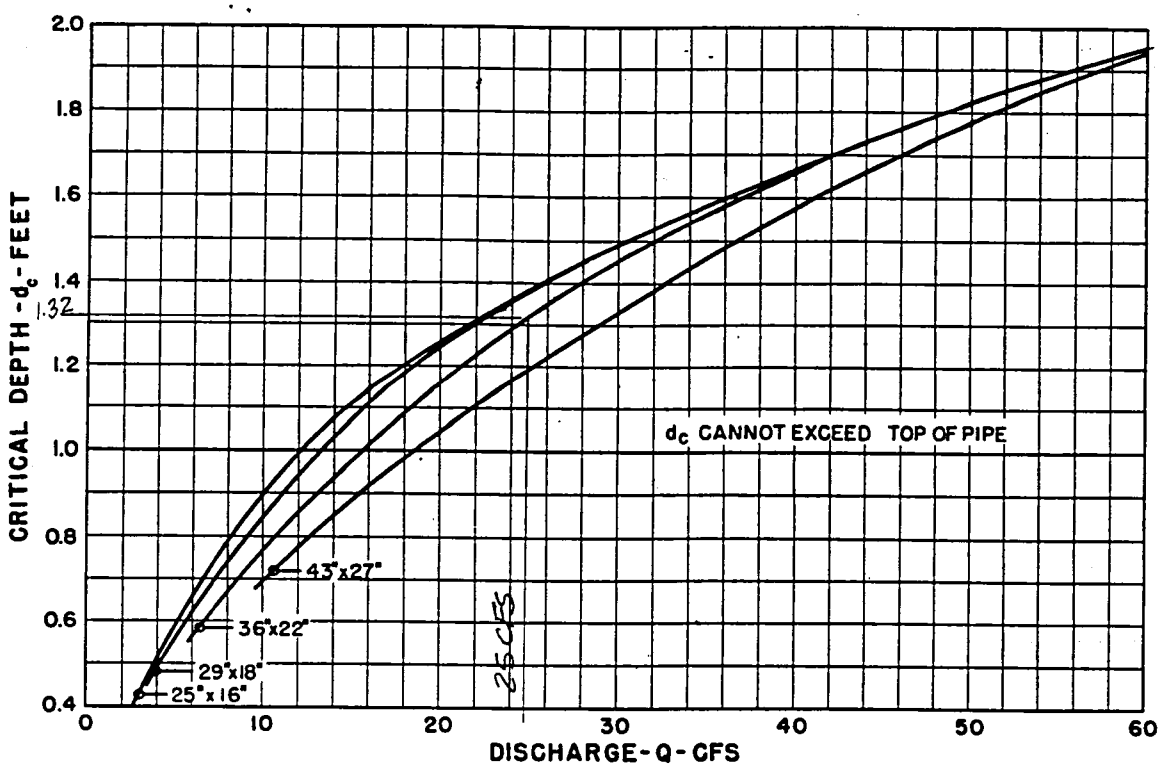
CHART 39

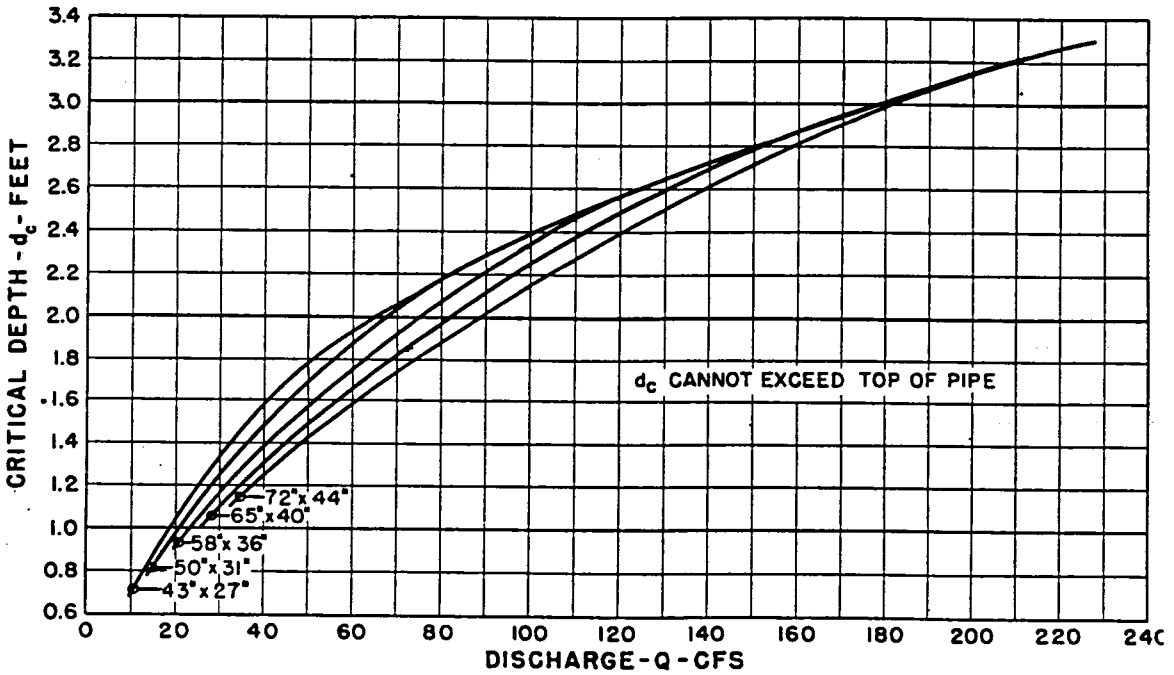


HEAD FOR
STANDARD C. M. PIPE-ARCH CULVERTS
FLOWING FULL
n=0.024

BUREAU OF PUBLIC ROADS JAN. 1963

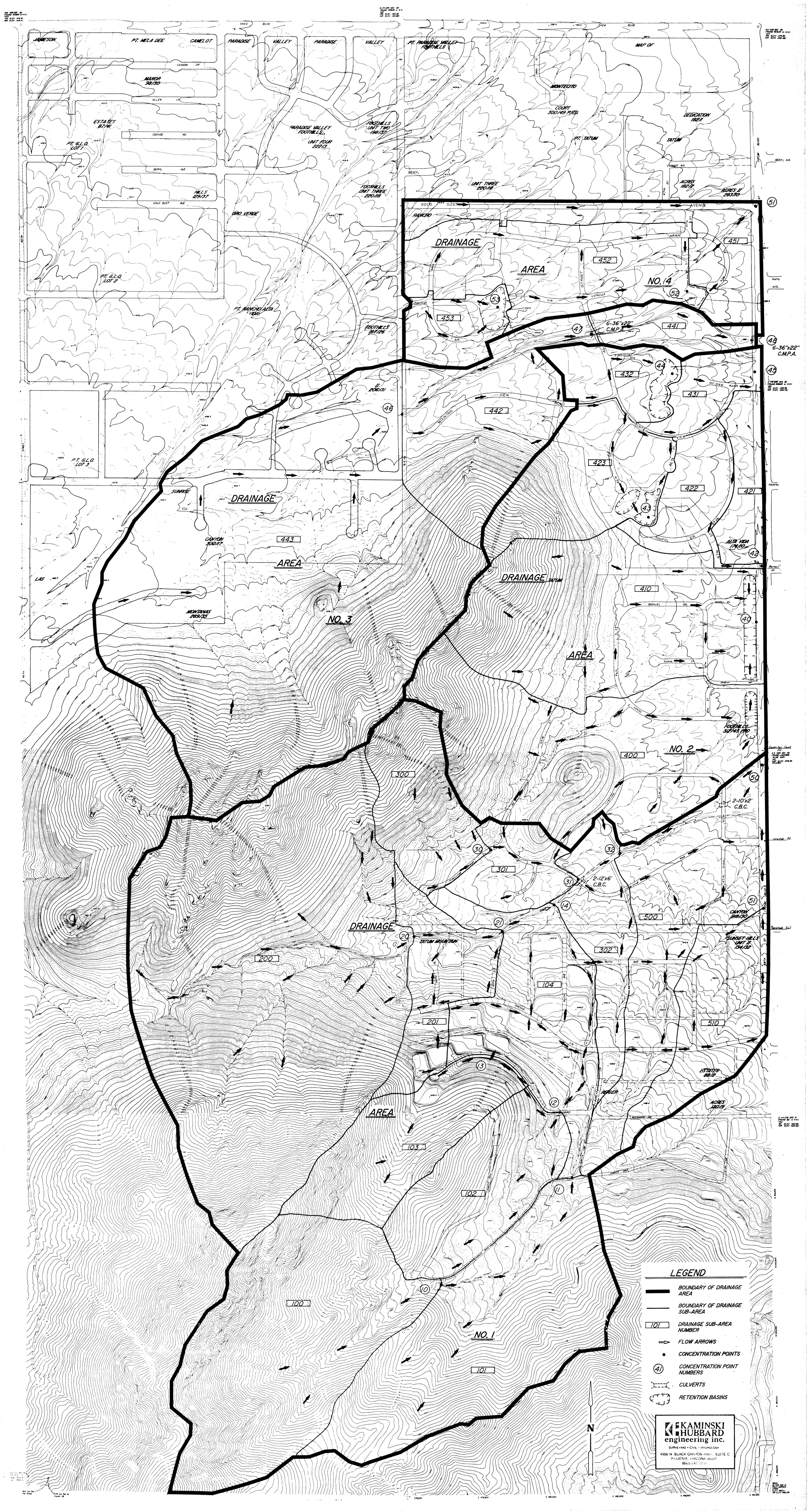
CHART 37





BUREAU OF PUBLIC ROADS
JAN. 1964

CRITICAL DEPTH
STANDARD C.M. PIPE-ARCH


DRAINAGE AREA NO. 1
DRAINAGE AREA NO. 2
DRAINAGE AREA NO. 3
DRAINAGE AREA NO. 4
LEGEND
BOUNDARY OF DRAINAGE AREA
BOUNDARY OF DRAINAGE SUB-AREA
101 DRAINAGE SUB-AREA NUMBER
FLOW ARROWS
CONCENTRATION POINTS
41 CONCENTRATION POINT NUMBERS
CULVERTS
RETENTION BASINS
N
KAMINSKI HUBBARD engineering inc.
SURVEYING • CIVIL • HYDROLOGY
4550 N. BLACK CANYON HWY. SUITE C
PHOENIX, ARIZONA 85017
(602) 241-0110