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SENSITIVITY OF SELECTED ILLUDAS PARAMETERS

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CONTENTS

Results

ABSTRACT

This report describes a study directed at providing the ILLUDAS user with a greater insight into the sensitivity of the model to variations in certain input parameters. These input parameters include antecedent moisture condition, hydrologic soil type, magnitude and frequency of storm event, time increment and sub-basin size. The effects of variations in these parameters on outlet hydrograph peak, pervious area runoff volume and required pipe sizes are presented. A single basin is used containing a representative distribution of residential land use. The results represent a documented experience with ILLUDAS which provides the user with additional assistance and confidence in choosing some of the input parameters which require some level of engineering judgement.

INTRODUCTION

The Illinois Urban Drainage Area Simulator (ILLUDAS) is a valuable engineering tool which can be utilized either as a design or an analysis (evaluation) model. In either mode, input information is required concerning the storm event, antecedent soil moisture conditions, and the hydrologic and hydraulic characteristics of the basin. Some of this information can be determined from field measurements or observations. However some of the input data require specific judgement, i.e., the antecedent soil moisture content.

Because ILLUDAS is a relatively new tool the typical user has had little, if any, experience in adapting it to a specific problem. Therefore questions may arise concerning the judgemental type of input data as to how sensitive the results are to these data. This report represents an attempt to examine the sensitivity of the ILLUDAS output to a few of what might be considered as the more important or sensitive input parameters. Since complete documentation of ILLUDAS is available elsewhere, ISWS Bulletin 58(1), it will be assumed that the reader has a working knowledge of the model.

Objectives

Input parameters were identified for study in terms of their effect on certain output parameters. These are identified below.

Input Parameters Studied

1. Antecedent moisture condition
2. Hydrologic soil group
3. Magnitude and frequency of storm event

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[1] Terstriep, M.L. and J.B. Stall, "The Illinois Urban Drainage Area Simulator, ILLUDAS," Illinois State Water Survey, Urbana, Bulletin 58, 1974.

4. Percent imperviousness of the basin
5. Time increment used for calculations
6. Size of sub-basins used to represent the total basin

Output Parameters Studied

1. Outlet hydrograph peak
2. Pervious area runoff volume
3. Pipe sizes chosen in design mode

It is the objective of this study to evaluate the sensitivity of the output parameters to the variations in the input parameters for a single basin. The quantitative results should not be thoughtlessly transferred to other basins since each is a unique case. They should be viewed, however, as a documented experience with ILLUDAS which hopefully can provide additional assistance and confidence in choosing some of the input parameters which involve some level of engineering judgement.

BASIN DESCRIPTION

Physical Characteristics

A single basin was used for the entire study. The basin (Crane Creek) was chosen because it was large enough to reflect the effect of the routing component in ILLUDAS but was not so large as to render as insignificant the contributions from any single subcatchment.

Crane Creek basin is located in Jackson, Mississippi. It is a 288 acre residential area including two large schools, a church, and an apartment complex. Street slopes range from 1 to 3 percent and yard slopes vary from 2 to 6 percent. The drainage system includes both open channel reaches and closed conduits and 25 percent of the area is impervious. Further information concerning the physical characteristics of Crane Creek as well as data used for the ILLUDAS verification study can be found in ISWS Bulletin 58.

ILLUDAS Representation

The basic model representation of Crane Creek basin used for most of this study was the same as used for the ILLUDAS verification study. The impervious area percentages were changed when the effect of that parameter was studied. Total sub-basin sizes and drainage systems remained the same except when the effect of sub-basin size was studied.

The existing basin was represented by 12 open channel reaches and 14 pipe reaches. A total of 188.1 acres was judged to contribute to the runoff hydrographs, including 44.9 acres of paved area, 14.4 acres of supplemental paved area and 128.8 acres of grassed area. The predominate soil type was hydrologic group C. Figure 1 shows a sketch of the ILLUDAS representation. A total of 9 branches are used with two of these being major branches. Appendix A summarizes the sub-basin and reach data used.

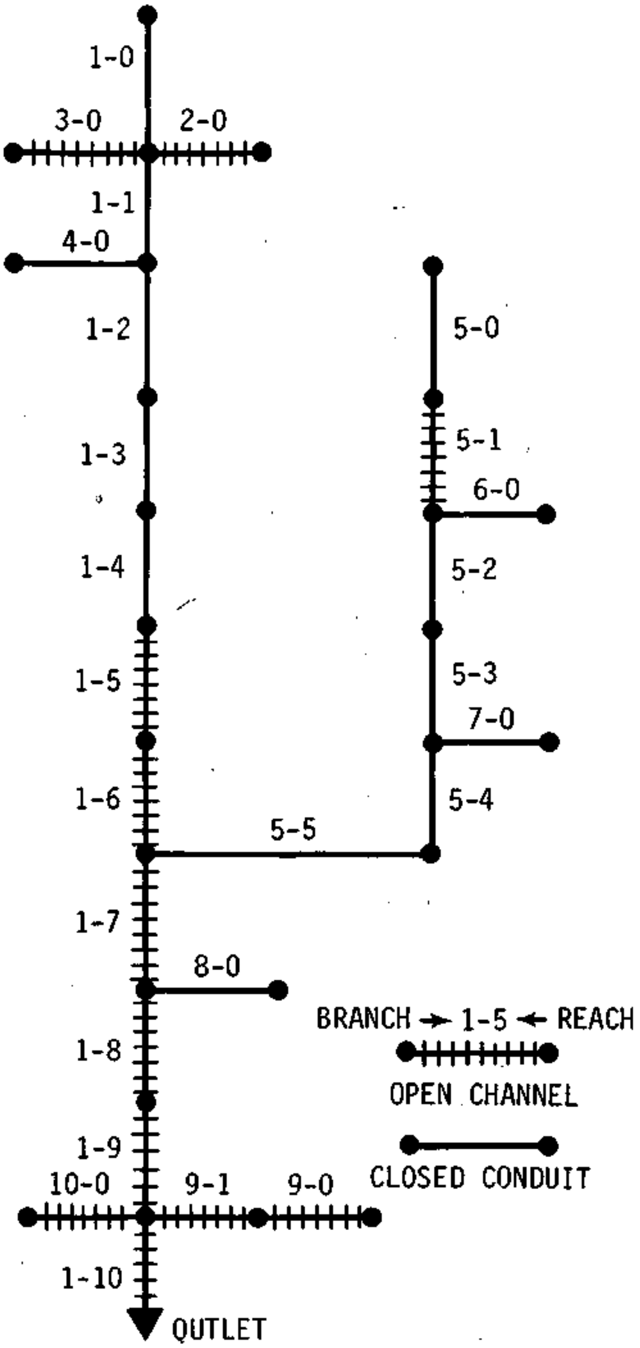

Figure 1. ILLUDAS Representation of Crane Creek Basin

RESULTS

Effect of Antecedent Moisture Condition and Soil Type in Outlet Hydrograph

A series of computer runs was made using the design mode in which, for each of the 16 possible combinations of soil type and antecedent moisture condition (AMC) as defined in Bulletin 58, rainfall events of four return periods and three conditions of imperviousness (0,25%,50%) were used. This required a total of 192 runs. The sub-basin and reach data for each condition of imperviousness remained the same except for the percentages of grassed and paved areas. Table 1 shows the specific values used.

Table 1 - Rainfall Input Data

Return Period, (yrs)	Total Rainfall (in)	Duration (hrs)
2	0.95	0.5
5	1.25	0.5
10	1.45	0.5
25	1.75	0.5

A 30 min duration was chosen for all events because a preliminary study using a limited number of runs showed that this duration produced the maximum peak on the outlet hydrograph in most cases. The distribution of rainfall during the 30 min duration was determined using the standard distribution which is built into ILLUDAS.

Outlet Hydrograph Peak

Figure 2 shows the sensitivity of the peak flows of the outlet hydrograph to changes in AMC. The graphs are plotted in terms of the percent of the peak for AMC 4 for each of the soil types. This peak corresponds to the highest initial water content in the soil and therefore is the maximum for any given soil type. It should be. pointed out that the actual peaks for each soil type for AMC 4 and thus for the reference values corresponding to 100 percent on the figures are not the same. This means that the absolute change in peak flow

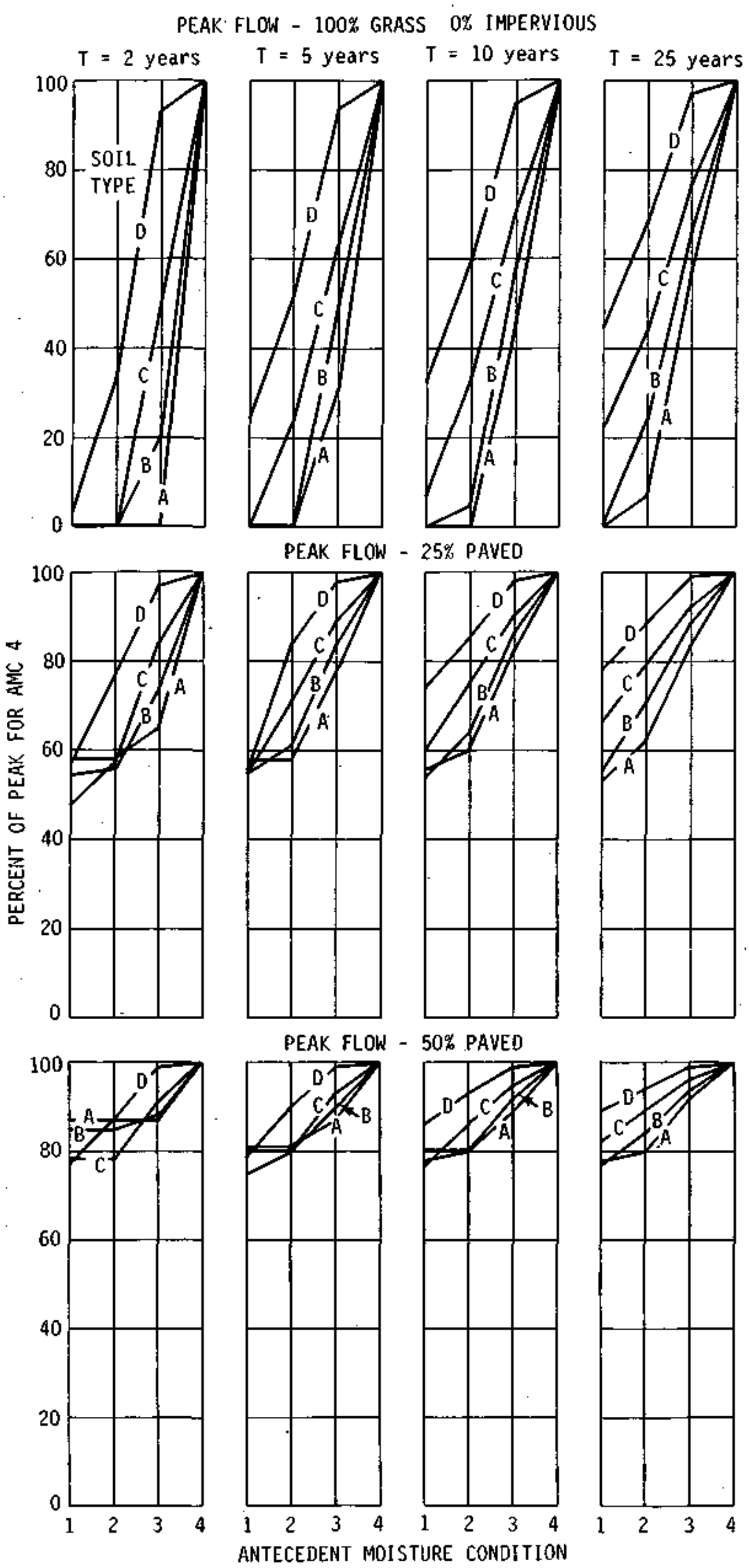

Figure 2. Sensitivity of Peak Flows to Changes in Antecedent Moisture Conditions

corresponding to a given percentage change in the figures depends on the soil type. The actual peak flows for each combination of parameters are given in appendix B.

The most obvious conclusion one can draw from Figure 2 is that the sensitivity, regardless of soil type or rainfall return period, is highly dependent on the percent imperviousness of the basin. It is possible, for example, to have no runoff at all from a basin with 100 percent grass. Of course a basin which is completely impervious will show no sensitivity to AMC or soil type. The curves indicate that in general sensitivity to changes in AMC increases as the infiltration capacity of the soil increases, that is as the soil type changes from D towards A. There is also a slight decrease in sensitivity as the return period and hence magnitude of the rainfall event increases. It is difficult to generalize on the variation in sensitivity with AMC at a given percent imperviousness except that the type D soil is consistently less sensitive to change from AMC 3 to AMC 4 than any other change in AMC for any type of soil. It should be pointed out that the horizontal lines in the figure, which correspond to no change in the peak flow, result from rainfall events which are not large enough to generate runoff from the pervious areas of the basin. Table 2 provides a general summary of sensitivity to AMC.

Table 2 - Sensitivity of Outlet Hydrograph Peak to AMC

Percent Imperviousness	Range of Percent Change per Unit Increase in AMC Number	Average Percent Change
0	20-60	30
25	5-25	15
50	3-12	5
100	0	0

Figure 3 shows the sensitivity of the peak of the outlet hydrograph to changes in soil type. The reference value corresponding to 100 percent is the peak for soil type D for each

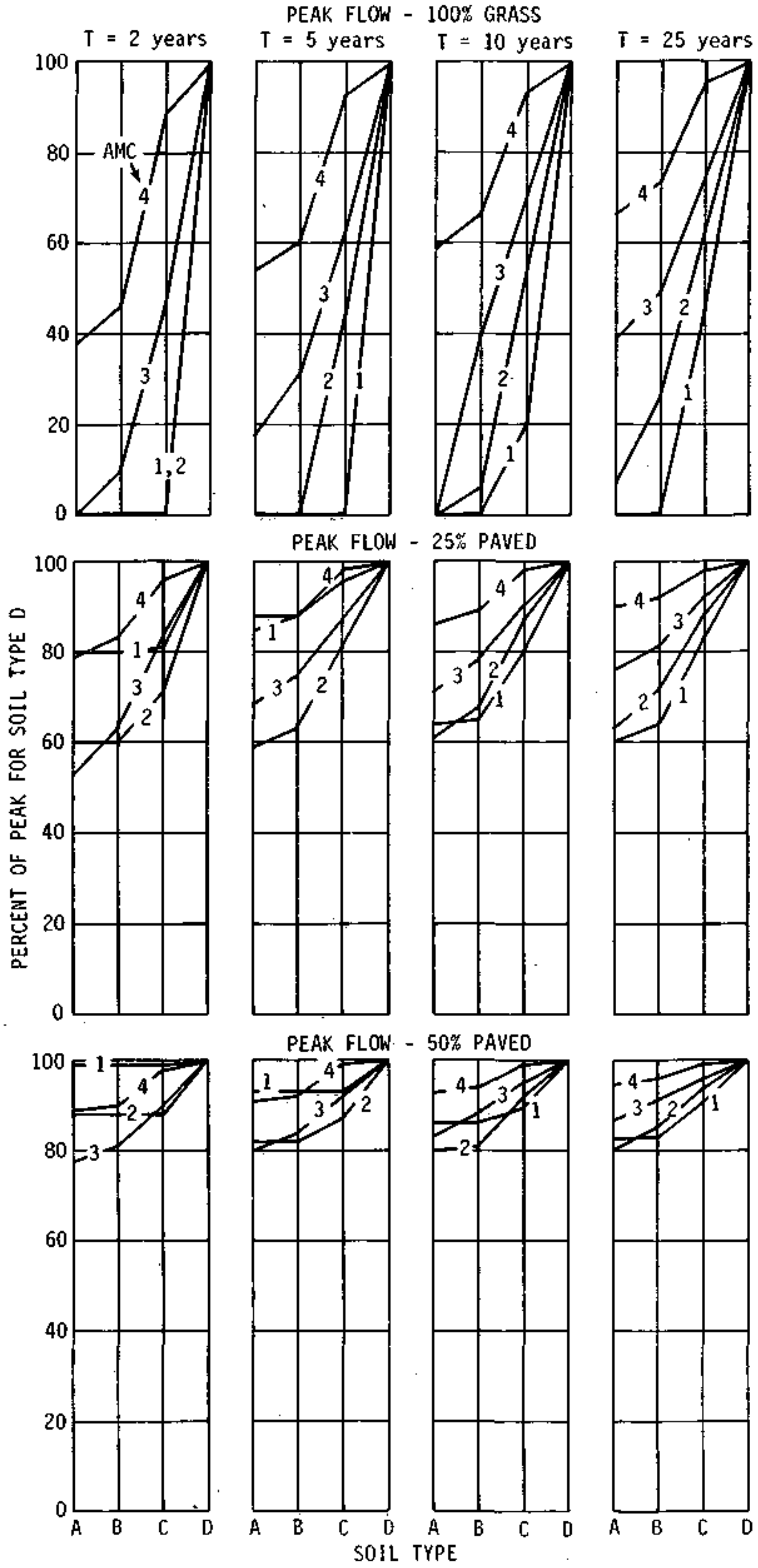

Figure 3. Sensitivity of Peak Flows to Changes in Soil Type

AMC and again it should be recognized that this peak is different for each value of AMC as well as each rainfall event return period. The actual peak flows are available in appendix B.

Since both soil type and AMC variations have the same general effect on runoff one might expect similar trends in sensitivity.. The actual effect of AMC in ILLUDAS is to establish a starting point on the infiltration curve for each soil type. These starting points or initial infiltration capacities are shown in Figure 4. Inspection of Figure 3 shows again the strong effect of imperviousness on sensitivity. Furthermore the range of sensitivity to soil type is about the same as for AMC. In general the sensitivity increases with decreasing AMC number or initial water content in the soil. As can be seen in Figure 4 a decreasing AMC number for any soil type implies a higher initial infiltration capacity. Therefore this trend is consistent with that described with respect to Figure 2. The trend of slightly reduced sensitivity as the magnitude of the rainfall event increases is also evident as well as the lower sensitivity for AMC 4. Table 3 summarizes the sensitivity to changes in soil type.

Table 3 - Sensitivity of Outlet Hydrograph Peak to Soil Type

Percent Imperviousness	Range of Percent Change per Unit Change in Soil Type	Average Percent Change
0	6-90	30
25	4-30	12
50	1-12	5
100	0	0

Time of Outlet Hydrograph Peak

An additional variable which was observed was the peak time. In general the peak time increased as the infiltration capacity of the soil decreased (soil type A toward D) and as the AMC number increased. This sensitivity was no more than a 5 minute (one time increment) or approximately a 20 percent increase for a unit change

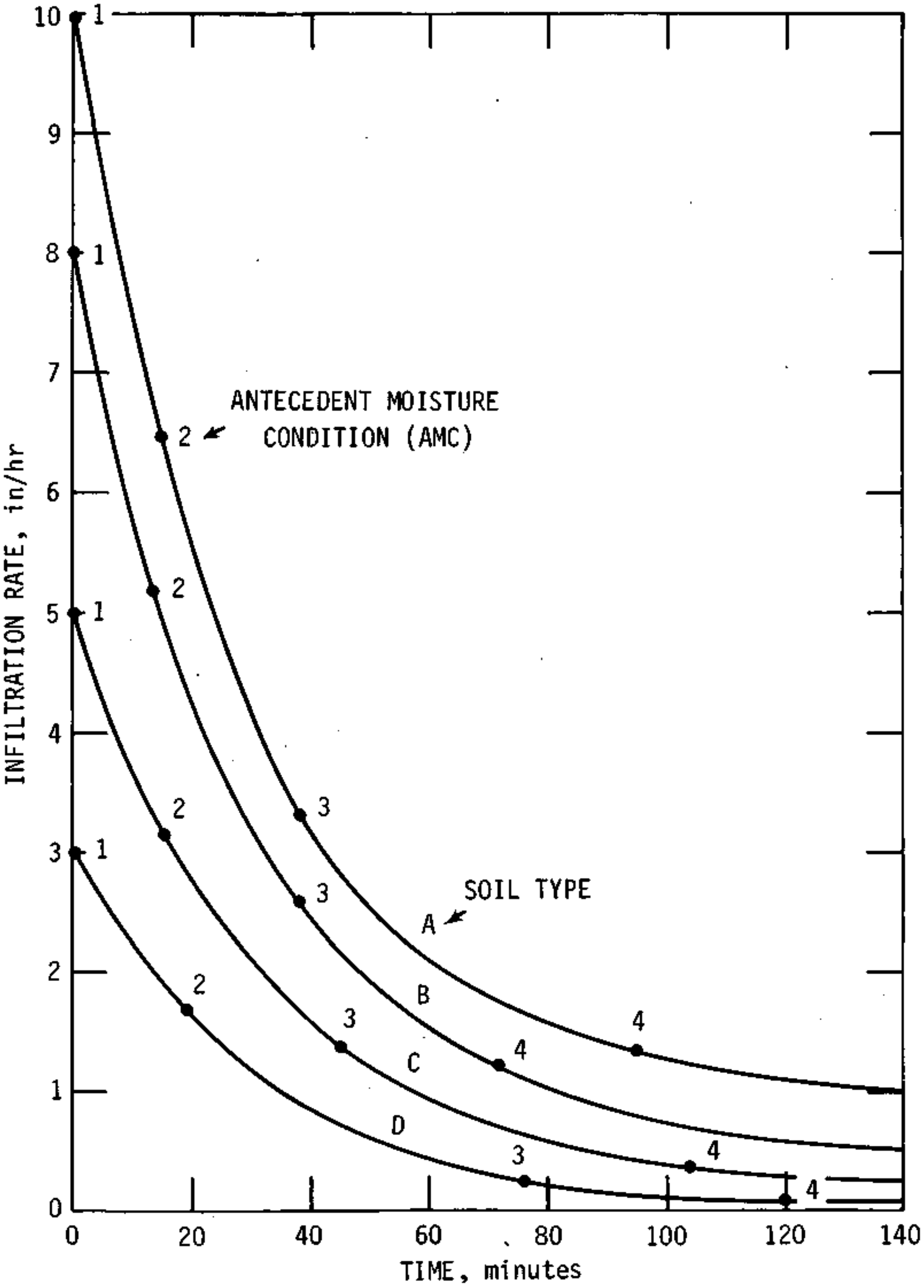

Figure 4. Starting Points on Infiltration Curves for Each Antecedent Moisture Condition

in either soil type or AMC. Furthermore, as the percent imperviousness increased this sensitivity decreased rapidly. At 25 percent imperviousness there was at most a 5 minute difference between the two extreme combinations of soil type and AMC. At 50 percent imperviousness there was no change in peak time at all. It can be concluded that peak time is not sensitive to soil type or AMC except for sub-basins with extremely high percentages of pervious area. The peak time decreased with increased percent imperviousness as would be expected. Table 4 summarizes typical results.

Table 4 - Outlet Hydrograph Peak Time Sensitivity to Imperviousness

Percent Imperviousness	Average Peak Time (min)
0	25
25	20
50	15
100	10

Pervious Area Runoff Volume

Because ILLUDAS computes and identifies the runoff volume from both pervious and impervious areas at the outlet it is possible to observe the sensitivity of this parameter to soil type and AMC. The pervious area runoff was studied since the runoff from the impervious area is independent of soil type or AMC and thus would be an additional constant volume for any rainfall event.

The results are presented in Figures 5 and 6, which show sensitivity to AMC and soil type, respectively. These figures are very similar to Figures 2 and 3 which is not surprising since one might expect a correlation between hydrograph volume and peak for a given basin. However the sensitivity of runoff volume to percent imperviousness does not exist because only pervious area runoff was considered. Therefore plots for 100 percent grass and 50 percent paved are identical to the data shown and the same general conclusions

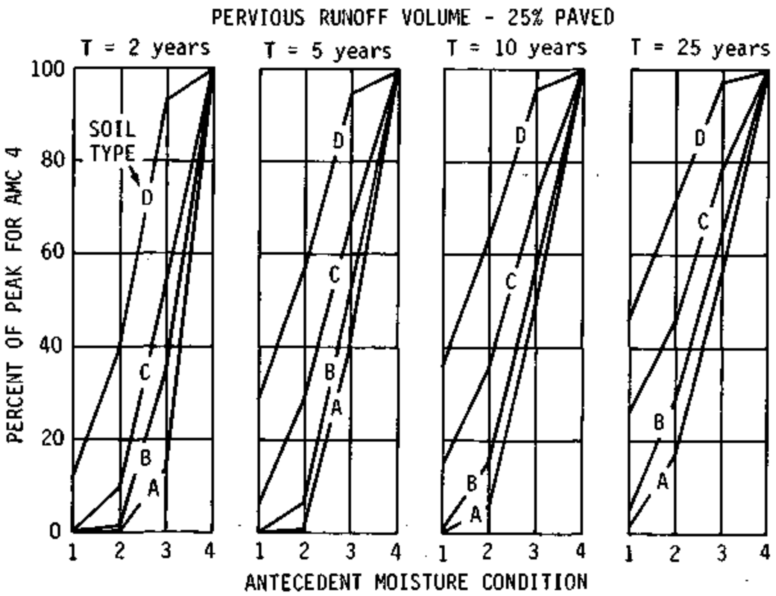

Figure 5. Sensitivity of Pervious Runoff Volume to Changes in Antecedent Moisture Condition

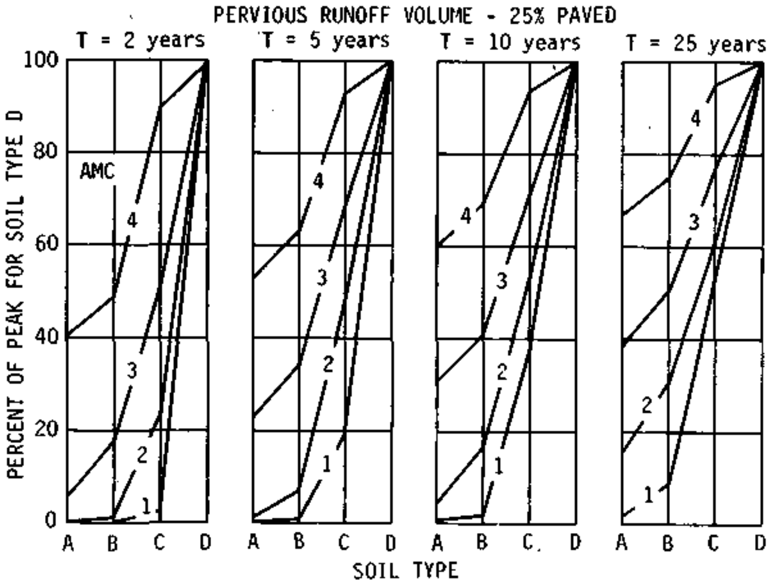

Figure 6. Sensitivity to Pervious Runoff Volume to Changes in Soil Type

that were made earlier with respect to soil type and AMC on peaks apply here as well as the data from Tables 2 and 3 for zero percent imperviousness.

Effect of Antecedent Moisture Conditions and Soil Type on Pipe Sizes

Another variable of interest when ILLUDAS is used in the design mode is the pipe size. One would expect pipe size to be less sensitive than discharge to AMC and soil type because each 3-in. size increment can accommodate a range of discharges. To investigate this the design diameters for two reaches were examined (reach 1-0 at the upstream end of the system and reach 5-5 well downstream). Only the 25 percent imperviousness case was studied since this best represents the real basin. Table 5 summarizes the results.

Table 5 - Sensitivity of Required Pipe Diameter to Soil Type and AMC

	Reach 1-0	Reach 5-5
Return Period of Rainfall Event (yrs)	Range of Pipe Dia. (in.) for all AMC and Soil Types	Range of Pipe Dia. (in.) for all AMC and Soil Types
2	15-21	39-45
5	18-24	45-51
10	18-24	48-54
25	21-27	51-57

As can be seen from Table 5, the maximum change in pipe diameter for a given rainfall event was 6 in. Furthermore, an examination of the variations for unit changes in either soil type or AMC shows a maximum change in pipe diameter of 3 in. A general guide on pipe size sensitivity would be that a change in either AMC or soil type would result in no more than an increase or decrease of 3 in. in the required pipe diameter for a given design return period.

Effect of Time Increment on Outlet Hydrograph

Another decision that the ILLUDAS user must make is a choice of time increment. If the increment is very small the increased amount and perhaps accuracy of the outflow hydrographs may not be justified by the increased computer costs. On the other hand if the time increment is too large the response to variations in rainfall intensity and to contributions of individual sub-basins may be so insensitive as to give poor or meaningless results.

A limited study of this variable was made by using ILLUDAS in the evaluation mode for a single storm which was used in the verification study for Crane Creek in ISWS Bulletin 58. Four time increments were used and the computed outlet hydrographs were compared to the observed hydrograph for the storm of July 24, 1965. The results in terms of the outlet hydrographs are shown in Figure 7. The hydrographs for 5 and 10 min increments are very close and the 15 min increment gave a 6 percent increase in outlet hydrographs. The 30 min increment hydrograph was not defined well enough to draw but the points are shown. It can be concluded that a time increment which is equal to the average paved area entry time for the sub-basins would be adequate. Little would be gained from a much smaller increment and a large increase above this value would result in a reduction in sensitivity and poor results. These results confirm the guidelines as to the selection of time increments which appear in Bulletin 58.

Effect of Sub-Basin Size on Outlet Hydrograph

The level of aggregation to use in an ILLUDAS representation of a basin is another decision the user must make. If the design mode is to be used the sub-basin size may be dictated by the layout of the drainage system. If the evaluation mode is used there may be more room for judgement as to how much detail should be involved in the modelling. As sub-basins become larger, the connecting reaches often become longer. If open channels are involved, lateral inflow can become a major factor. Since ILLUDAS assumes

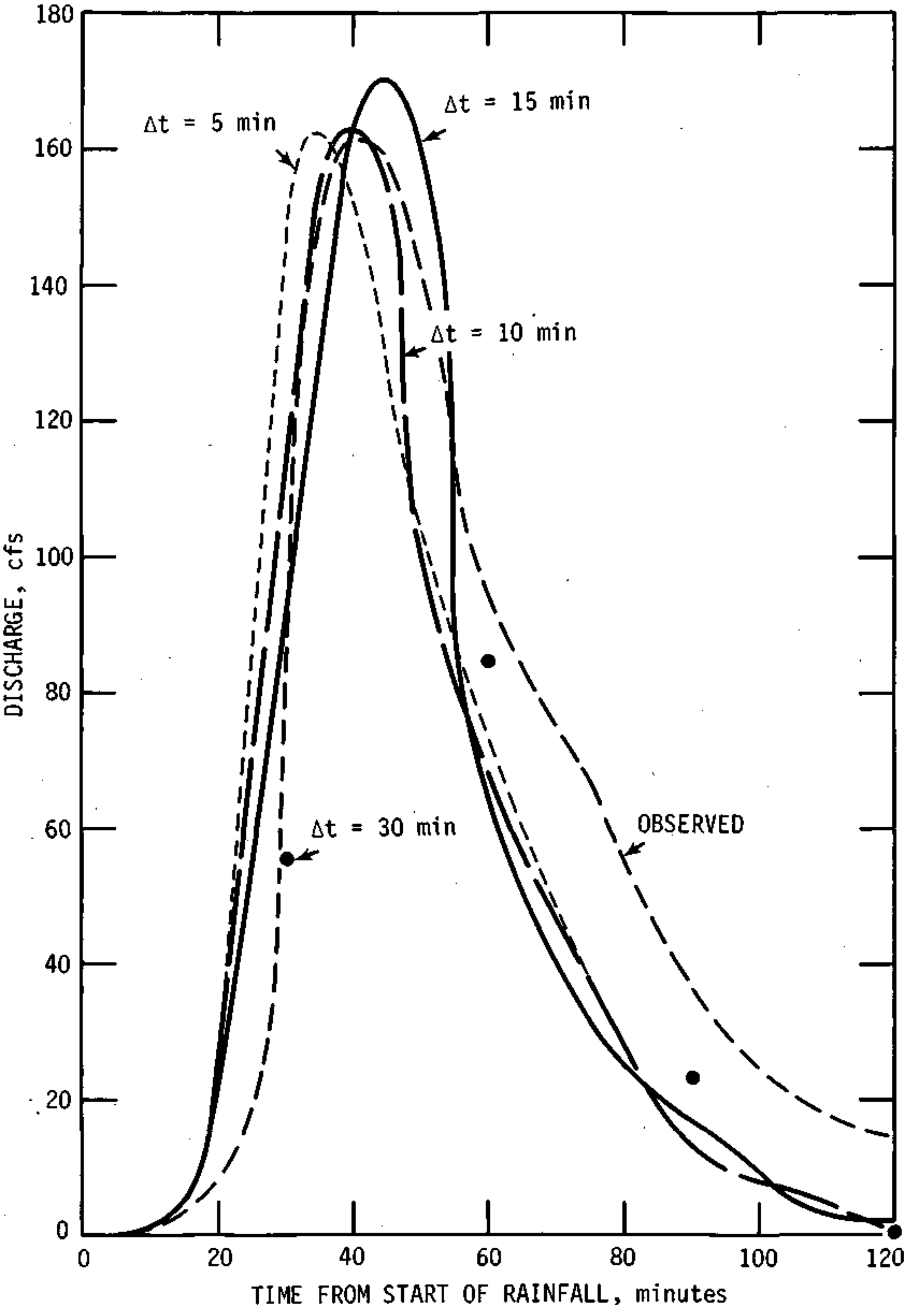

Figure 7. Outfall Hydrographs for the Storm of July 24, 1965, on Crane Creek for time increments of 5, 10, 15, and 30 minutes.

that flow is concentrated at the lower end of the reach, long open channel reaches should be avoided. As a general rule, travel time in any reach should not exceed the time increment, which in turn should not exceed the inlet time.

One example is presented in which a new representation of the Crane Creek basin is developed by decreasing the number of sub-basins from 26 to 11. This was done by grouping two or three of the original sub-basins into a single sub-basin and estimating the necessary parameters for the new sub-basin based on those of the originals. The resulting representation is shown in Figure 8 and a comparison of data is shown in Table 6. A complete summary of the data is given in appendix A.

Table 6 - Comparison of Original and Large Sub-Basin Data

	Original	Large
Number of Sub-basins	26	11
Average Area (acres)	7.25	17.1
Average Paved Area Entry Time (min)	11.3	13.6
Average Length of Flow over Grassed Area (ft)	311	451

Figure 9 shows the observed hydrograph for the storm of July 24, 1965, the 26 sub-basin reproduction of the event, and the 11 sub-basin reproduction of the event. In this example, the reduction of sub-basins and the removal of a significant amount of data did not significantly affect the results. The longest reach in the 11 sub-basin representation was 1600 feet. At 5 fps, travel time in this reach would have been 5.3 min or approximately equal the travel time. A further reduction in the number of sub-basins could be expected to adversely affect the results.

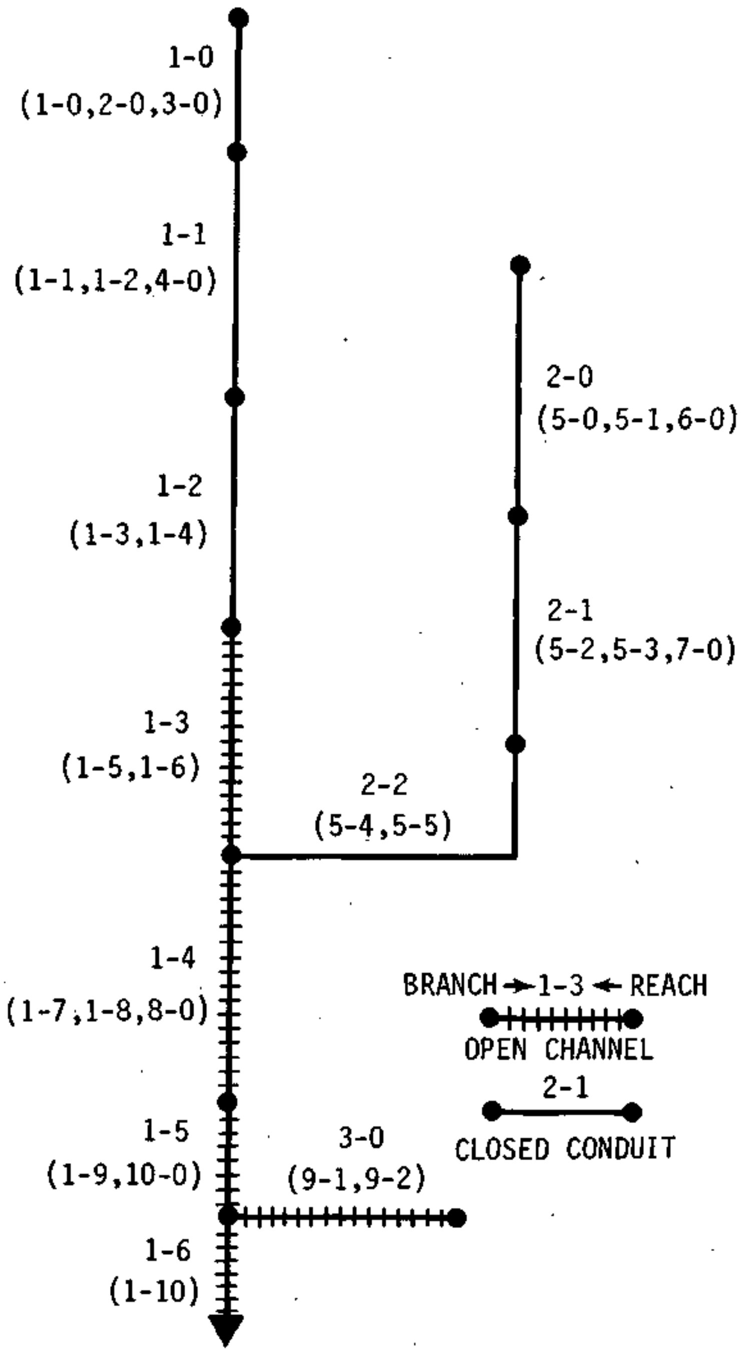

Figure 8. Large Sub-basin ILLUDAS Representation of Crane Creek Basin

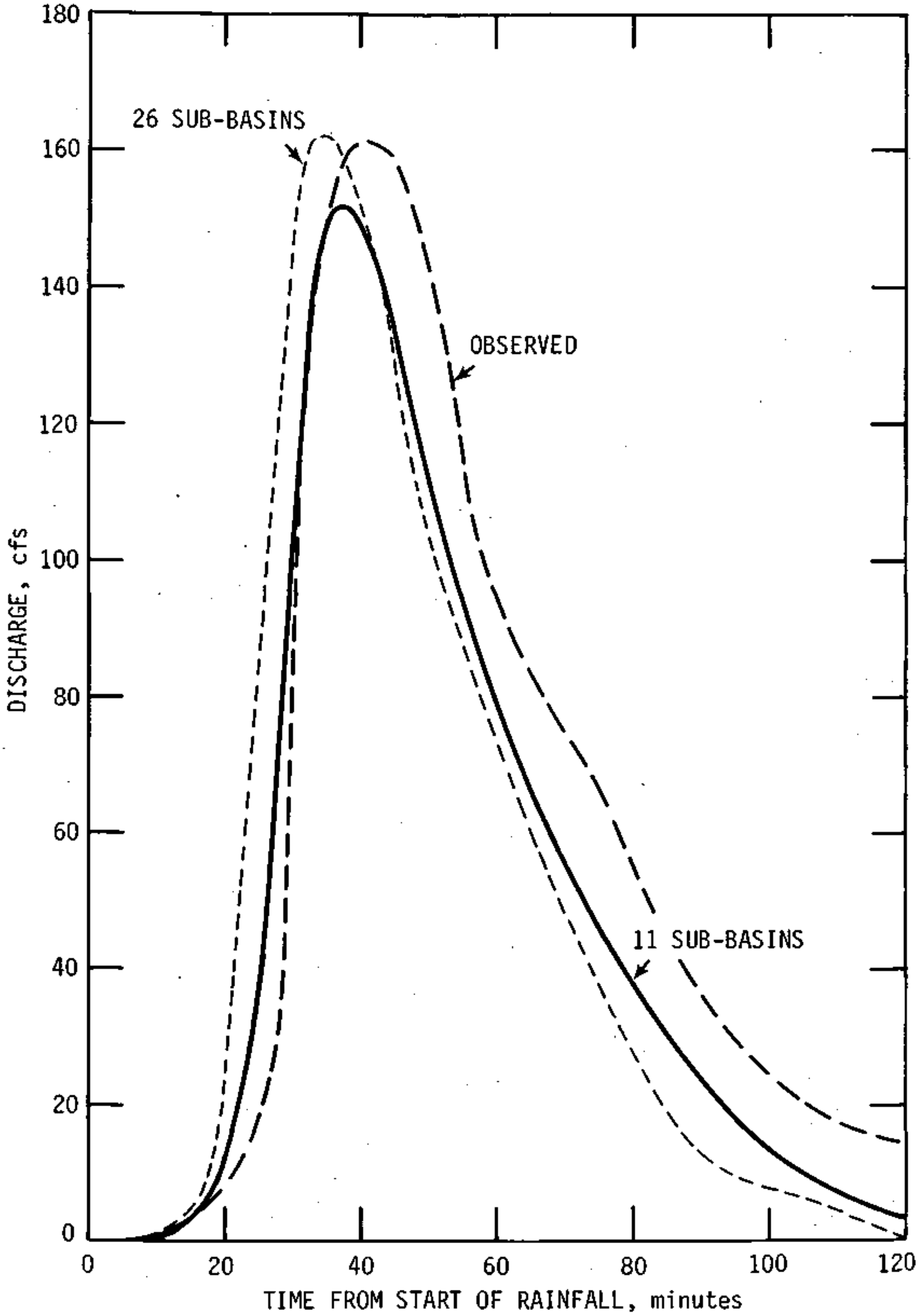

Figure 9. Outfall Hydrographs for the Storm of July 24, 1965, on Crane Creek using 11 and 26 Sub-basins

Appendix A - ILLUDAS Data for Crane Creek

The following data were used to model the Crane Creek Basin for all runs except those discussed in Section 3.4 The branch and reach configuration is shown in Figure 1 and the data are tabulated consistent with the format as described on pages 83-87 of ISWS Bulletin 58.

Card III - Basin Parameters

Basin Area - 288 ac

Paved Area Abstraction - 0.1 in.

Grassed Area Abstraction - 0.2 in.

Predominate Soil Group - 3 (evaluation node)

Minimum Diameter - 6 in.

New Pipe 'n' - 0.015

Card IV - Rainfall Parameters

Number of Rainfall Increments(1) - 35

Time Increment(2) - 5 min

Duration(1) - 60 min

Total Rainfall(1) - 2.0 in.

Antecedent Moisture Condition(1) - 2

Card V(3) - Rainfall Data

0, .10, .06, .08, .07, .03, .01, .01, .01, .01,
.01, .13, .29, .15, .11, .01, .01, .02, .10, .05,
.03, .01, .01, .02, .04, .01, 0, 0, .01, 0,
0, 0, .04, .01

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(1) Values shown are for evaluation mode only. See Table 1 for design mode values.

(2) Values shown are used for all runs except where effect of time increment was studied.

(3) Data for storm of July 24, 1965 used in evaluation mode. For design mode standard distribution was used for data in Table 1.

Card VI - Reach Data

Item No.	1	2	3	4	5	6	7	8	9	10	11	12	13
			CONFLUENCE										
	BR	RCH	ENDB	CONB	OP	LEN	SLP	N	S	DIA	H	W	LS
	1	0				300	0.5	.015	1	30			
	2	0			2	850	2.5	.025	3			1.0	1.0
	3	0			2	850	2.5	.025	3			1.0	1.0
			2	1									
			3	1									
	1	1				320	0.3	.015		51			
	4	0				740	1.0	.015		24			
			4	1									
	1	2				300	0.7	.015		51			
	1	3				600	0.3	.015		58			
	1	4				400	0.3	.015		58			
	1	5			2	600	1.6		3			5.0	1.0
	1	6			2	300	1.0		3			5.0	1.0
	5	0				570	1.0	.015		30			
	5	1			2	400	1.0	.015	2		2.3	3.7	
	6	0				500	2.5	.015		24			
			6	5									
	5	2				450	0.5	.015		36			
	5	3				500	4.0	.015		18			
			7	-5									
	5	4				1300	1.0	.015		54			
	5	5				300	1.0	.015		54			
			5	1									
	1	7			2	200	1.0	.015	3			9.5	1.5
	8	0				400	3.2	.015		21			
			8	1									
	1	8			2	750	1.0	.015	3			9.0	1.5
	1	9			2	300	1.0	.015	3			8.0	1.0
	9	0			2	550	3.0	.025	3			5.0	0.3
	9.	1			2	450	2.0	.025	3			5.0	0.3
			9	1									
	10	0			2	850	0.4	.015	3			5.0	0.2
			10	1									
	1	10			2	10	0.8	.015	3			8.0	1.0

Card VII - Sub-basin Data

Item No.	1	2	3	4	6	8	11	14	15
	BR	RCH	AREA	DCPA	SPA	P ENT	GA	GL	GS
	1	0	6.48	1.88	1.2	22	3.4	40	2.0
	2	0	13.75	1.85	0	15	11.9	700	3.0
	3	0	5.29	0.59	0	12	4.7	600	3.0
	1	1	5.93	1.73	1.0	10	3.2	40	2.0
	4	0	4.52	1.12	0.6	13	2.8	40	2.0
	1	2	6.44	1.84	1.0	14	3.6	40	3.0
	1	3	10.50	2.70	1.6	18	6.2	40	6.0
	1	4	5.78	1.48	0.9	17	3.4	40	5.0
	1	5	10.26	2.96	1.8	21	5.5	40	4.0
	1	6	11.24	0.54	0.7	15	10.0	500	3.0
	5	0	8.18	1.88	0	5	6.3	700	6.0
	5	1	14.47	3.97	0	5	10.5	400	4.0
	6	0	5.61	3.91	0	5	1.7	200	4.0
	5	2	5.04	1.64	0	8	3.4	600	4.0
	5	3	10.87	1.87	0	5	9.0	990	5.0
	7	0	4.89	2.89	1.0	6	1.0	400	4.0
	5	4	5.15	0.55	0	7	4.6	500	5.0
	5	5	9.75	5.55	0.9	8	3.3	300	4.0
	1	7	6.45	0.45	0.5	10	5.5	300	3.0
	8	0	4.08	1.08	0.5	6	2.5	40	4.0
	1	8	3.02	0.32	0.2	10	2.5	200	3.0
	1	9	7.28	0.58	0.3	10	6.4	600	3.0
	9	0	7.61	1.91	0.5	7	5.2	300	10.0
	9	1	2.81	0.31	0.5	10	2.0	100	6.0
	10	0	3.95	0.95	0.8	20	2.2	70	4.0
	1	10	8.76	0.36	0.4	15	8.0	300	3.0

The study of the effect of sub-basin size was done using larger sub-basins which were composed of aggregations of the sub-basins shown in Figure 1. The larger sub-basin configuration is shown in Figure 12. The data for these are taken from the data given above. The first five data cards do not change. The remaining data are given below.

Card VI - Reach Data (Large sub-basins)

Item No.	1	2	3	4	5	6	7	8	9	10	11	12	13
			CONFLUENCE										
	BR	RCH	ENDB	CONB	OP	LEN	SLP	N	S	DIA	H	W	LS
	1	0			2	850	2.5	.015	3			1.0	1.0
	1	1				740	1.0	.015		51			
	1	2				1000	0.3	.015		58			
	1	3			2	900	1.3	.025	3			5.0	1.0
	2	0				970	1.0	.015		30			
	2	1				570	0.5	.015		48			
	2	2				1600	1.0	.015		54			
			2	1									
	1	4			1	950	1.0	.015	3			9.0	1.5
	1	5			2	850	0.4	.025	3			5.0	0.2
	3	0			2	1000	2.5	.025	3			5.3	0.3
			3	1									
	1	6			2	10	0.8	.015	3			8	1.0

Card VII - Sub-Basin Data (Large sub-basins)

Item No.	1	2	3	4	6		8	11	14	15
	BR	RCH	AREA	DCPA	SPA	P	ENT	GA	GL	GS
	1	0	25.52	4.32	1.2		22	20.0	700	3.0
	1	1	16.89	4.69	2.6		14	9.6	40	3.0
	1	2	16.28	4.18	2.5		18	9.6	40	5.0
	1	3	21.50	3.50	2.5		21	8.9	500	3.0
	2	0	28.26	9.76	0		5	18.5	700	6.0
	2	1	20.80	6.40	1.0		6	13.4	990	5.0
	2	2	14.90	6.10	0.9		8	7.9	500	5.0
	1	4	13.55	1.85	1.2		10	10.5	300	3.0
	1	5	11.23	1.53	1.1		20	8.6	600	3.0
	3	0	10.42	2.22	1.0		10	7.2	300	10.0
	1	6	8.76	0.36	0.4		15	8.0	300	3.0

Appendix B - Results of Computer Runs for all Combinations of Input Parameters

Return Period	Percent Impervious	AMC	Peak Flow cfs				Pervious Runoff Volume 1000 ft^3			
			A	B	C	D	A	B	C	D
2	0	1	0	0	0	6	0	0	0	14
2	0	2	0	0	0	65	0	0	0	151
2	0	3	0	18	81	176	0	43	185	436
2	0	4	72	88	168	190	164	199	417	474
5	0	1	0	0	0	67	0	0	0	153
5	0	2	0	0	61	142	0	0	139	343
5	0	3	46	80	159	257	105	182	388	638
5	0	4	147	164	252	273	325	394	620	677
10	0	1	0	0	22	109	0	0	51	246
10	0	2	0	11	102	193	0	26	231	478
10	0	3	88	125	214	311	198	277	524	774
10	0	4	194	218	306	328	441	529	7.56	813
25	0	1	0	0	84	182	0	0	190	403
25	0	2	20	72	172	278	48	164	381	681
25	0	3	154	196	295	396	336	438	727	978
25	0	4	269	297	388	408	642	732	959	1016
2	25	1	98	98	98	122	0	0	1	44
2	25	2	98	98	117	164	1	1	34	149
2	25	3	111	131	173	707	21	64	176	348
2	25	4	169	177	206	213	151	182	334	374
5	25	1	148	148	163	169	0	1	29	152
5	25	2	150	160	208	253	4	22	140	300
5	25	3	200	221	261	295	116	173	331	502
5	25	4	257	264	294	301	281	334	490	528
10	25	1	174	176	215	270	1	5	87	229
10	25	2	186	208	266	307	21	69	215	403
10	25	3	255	279	320	357	188	251	434	605
10	25	4	312	324	356	363	376	437	593	632
25	25	1	217	231	299	360	6	32	193	364
25	25	2	255	292	355	405	89	175	342	557
25	25	3	343	369	416	453	299	385	588	760
25	25	4	411	420	452	459	530	592	747	786
2	50	1	220	220	220	222	0	0	0	7
2	50	2	220	220	220	250	0	0	0	80
2	50	3	220	228	256	283	0	22	93	218
2	50	4	254	259	282	287	82	100	209	237
5	50	1	300	300	300	322	0	0	0	77
5	50	2	300	300	320	366	0	0	69	171
5	50	3	322	339	372	403	53	91	194	320
5	50	4	370	375	402	407	163	197	310	339

Appendix B - Results of Computer Runs for All Combinations of Input Parameters

			Peak Flow cfs				Pervious Runoff Volume 1000 ft^3			
Return Period	Percent Impervious	AMC	A	B	C	D	A	B	C	D
10	50	1	356	356	366	412	0	0	26	123
10	50	2	356	361	409	445	0	13	116	239
10	50	3	398	419	451	477	99	138	202	387
10	50	4	447	454	476	481	221	265	378	406
25	50	1	434	434	479	526	0	0	95	202
25	50	2	445	473	522	555	24	82	191	341
25	50	3	511	533	561	587	168	219	363	489
25	50	4	558	565	586	590	321	366	480	508

Results from Impervious Surfaces
(Independent of Soil Type and AMC)

		Peak Plow cfs	Impervious Runoff Volume 1000 ft^3
2	25		137
5	25		186
10	25		218
25	25		267
2	50		287
5	50		389
10	50		457
25	50		559
2	100	540	578
5	100	755	782
10	100	880	925
25	100	1106	1131