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MAIER,J.E. Rochester Gas & Electric Corp.
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CRUTCHFIELD,D. Operating Reactors Branch 5

SUBJECT: Discusses SEP Topics II-3.B, "Flooding Potential," II-3.B.1, II-3.c & III-3.c & NRC conclusion that util should provide protection from flooding of Deer Creek.NUS Corp std project flood peak analysis concludes site adequately protected.

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JOHN E. MAIER
Vice President

TELEPHONE
AREA CODE 716 546-2700

June 25, 1982

Director of Nuclear Reactor Regulation
Attention: Mr. Dennis M. Crutchfield, Chief
Operating Reactors Branch No. 5
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: SEP Topics II-3.B, II-3.B.1, II-3.C, III-3.C,
"Flooding Potential - Deer Creek"
R. E. Ginna Nuclear Power Plant
Docket No. 50-244

Dear Mr. Crutchfield:

RG&E submitted a report entitled "Ginna Station Design Basis Flooding Study" by letter dated August 18, 1981. In that report, RG&E concluded that the Deer Creek channel is capable of carrying a 12-inch in 24 hour rainfall event, with an associated Deer Creek peak flow of 13,700 cfs, without exceeding a flood level of 270 ft msl (plant grade). The estimated return period of this event, in excess of tens of thousands of years, was deemed sufficiently great by RG&E that no additional measures were considered to be required to prevent site flooding.

The NRC responded, by letter dated April 26, 1982 and the attached Technical Evaluation Report "Hydrological Considerations" by Franklin Research Center. In that report, the NRC estimated that, based on the peak floods resulting from the maximum rainfall that has occurred historically in the general vicinity of the Ginna site, a peak flood resulting in a flow of approximately 30% of the capacity of the Deer Creek channel could be expected to occur, with a recurrence interval of several hundreds of years. It should be noted that this result is comparable to the estimate made in RG&E's report of August 18, 1981.

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The April 26 NRC letter also noted that the Standard Project Flood (SPF) peak discharge for Deer Creek is estimated to be about 15,000 cfs. In the NRC's draft Integrated Plant Safety Assessment Report (NUREG-0821), published May 27, 1982, Section 4.5, the NRC concludes that RG&E should provide protection from flooding of Deer Creek to the levels produced by the Standard Project Flood plus one foot. In response to this recommendation, RG&E contracted with NUS to perform an SPF analysis for the Ginna site, to determine what type of protection would be required.

The results of the NUS study (provided as Attachment 1) demonstrate that, using site-specific information regarding site conditions, rather than the conservative estimates used in the FRC report, the SPF would be contained by the Deer Creek channel, with almost one foot of margin (see Table 2 of Attachment 1). No site flooding would result. There is additional margin to flooding already incorporated at the site. Curbs and dams in and around the screenhouse and diesel generator rooms, which are at grade elevation 253 ft msl, provide protection to at least 15 inches above grade (this was noted in the NRC's Safety Evaluation Report). No additional margin is considered warranted at the Auxiliary Building, which is at grade elevation 270 ft msl. Thus, no additional protection for plant safety-related equipment is required relative to Deer Creek flooding.

RG&E has also estimated the recurrence interval for the Standard Project Flood, and concluded that it would be in excess of tens of thousands of years. Thus, because of the small likelihood of the occurrence of an SPF, and the additional margin above grade provided at lower site elevations, RG&E concludes that the Ginna site is adequately protected from flooding due to Deer Creek, and that all concerns regarding this subject should now be alleviated.

Very truly yours,

John E. Maier

John E. Maier

Attachment 1

GINNA STATION STANDARD PROJECT FLOODING STUDY

STUDY PURPOSE

Franklin Research Center (FRC) prepared a report (1) for the Nuclear Regulatory Commission (NRC) commenting on an earlier NUS study (2) of design basis flooding for Rochester Gas & Electric Corporation's Ginna Station. The station is located along Lake Ontario in the Deer Creek Watershed as shown in Figure 1. The major thrust of FRC's report was that flood return periods greater than about 500 years can not be predicted very accurately with the limited time period of available data (a point also brought out in the NUS report). FRC presents a Standard Project Flood (SPF) which represents "flood discharges that may be expected from the most severe combination of meteorologic and hydrologic conditions that are considered reasonably characteristic of the geographical region involved, excluding extremely rare combinations."(3) They determined an SPF of 15,000 cfs based on certain assumptions and parameter selection. They do not present the accompanying water elevations although they indicate that the plant will be flooded by any flow greater than 12,000 cfs. This report presents our best estimates of the SPF, the corresponding water surface elevations, and its probability of occurrence. Quantitative and qualitative comparisons between these results and those of the FRC report are also included.

STANDARD PROJECT STORM (SPS)

The SPS index rainfall was obtained from Figure 2 (Plate 2 of Ref. 3) for the Ginna Station environs as 9.5 inches. Figure 3 (Plate 9 of Ref. 3) relates this index rainfall to the area of the drainage basin and the storm duration in order to obtain an SPS index rainfall ratio which, for the Deer Creek drainage area of 13.9 sq. mi. (2) and the minimum indicated duration, 24 hours, is 116%. However, in order to be both consistent with the FRC report and conservative a value of 118% was chosen. Therefore, the 24-hour SPS for the Ginna Station is 11.2 inches (9.5 X 1.18).

Figure 4 (Plate 10 of Ref. 3) gives the time distribution of the 24-hour rainfall in consecutive 6-hour intervals. Applying this distribution to the Ginna Station SPS of 11.2 inches results in rainfall of 0.51, 1.41, 8.42, and 0.86 inches for the four 6-hour periods of the SPS. The maximum 6 hour rainfall of 8.42 inches is further broken down, using Figure 5 (Plate 11 of Ref. 3), into consecutive hourly rainfall depths of 0.84, 1.01, 1.26, 3.20, 1.18, and 0.93 inches.

STANDARD PROJECT FLOOD (SPF)

The HEC-1 computer code (4) was used to calculate the flow of the SPF from the above described SPS. The Soil Conservation Service dimensionless unit hydrograph option, which is designed for small ungaged watersheds such as Deer Creek, was used to estimate the discharge. The antecedent moisture condition (AMC) of the soil was chosen for this study as condition II, "an average of the conditions which have preceded the occurrence of the maximum annual flood on numerous watersheds."(5) Using curve number (CN) 85, (2) which describes

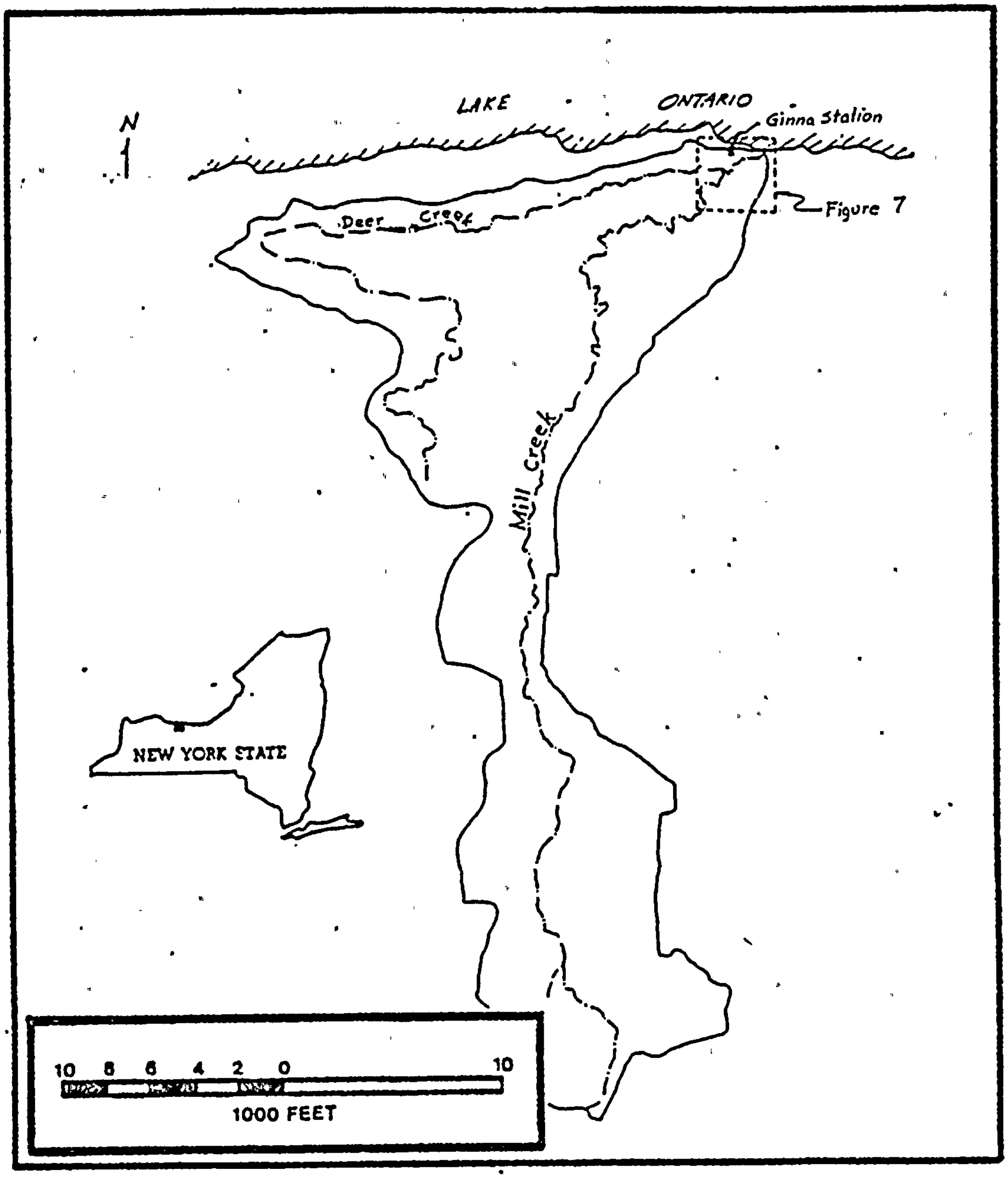

Figure 1. Ginna Station Location

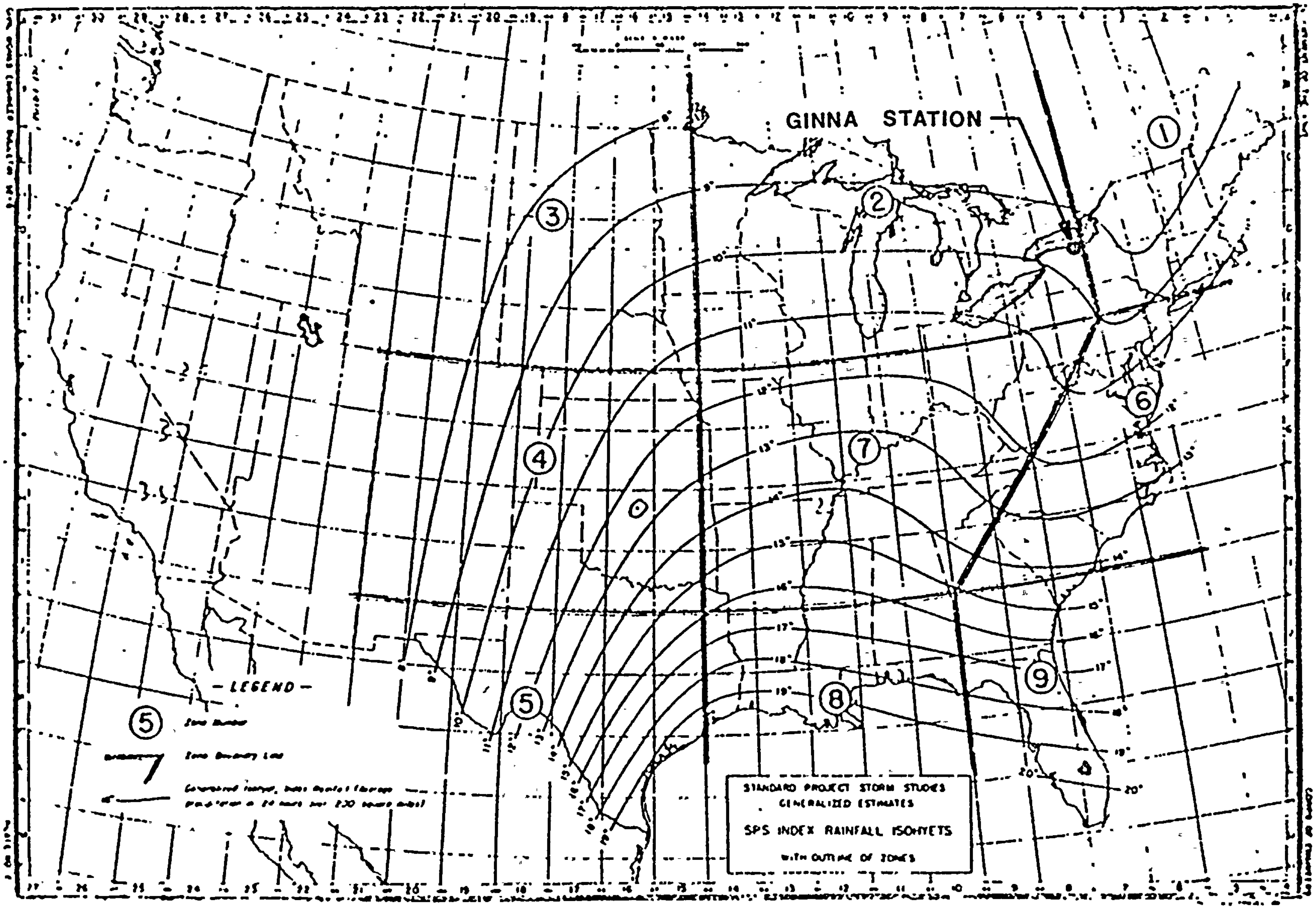

Figure 2. Standard Project Storm Index Rainfall

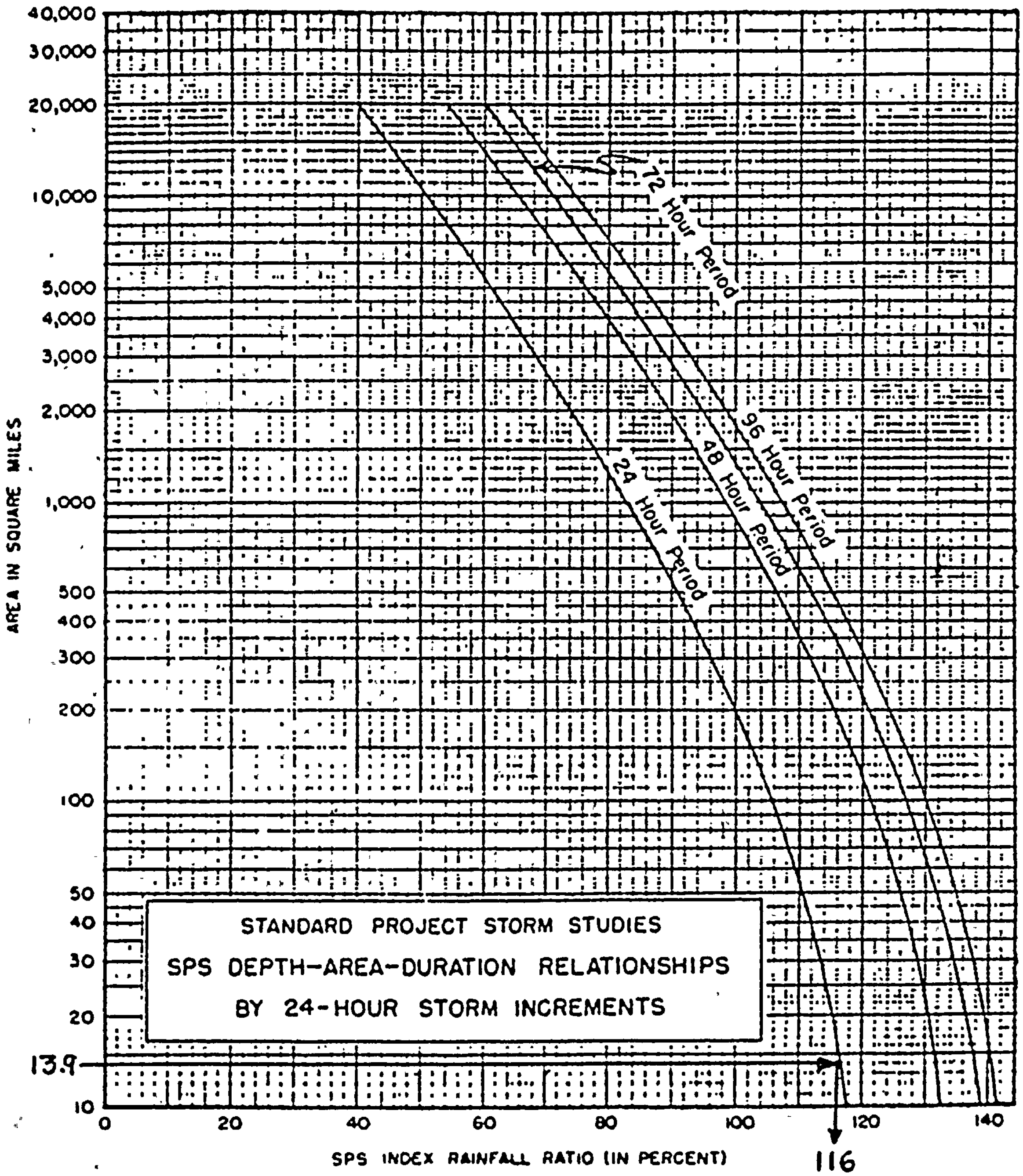

Figure 3. Standard Project Storm Depth-Area-Duration Relationships

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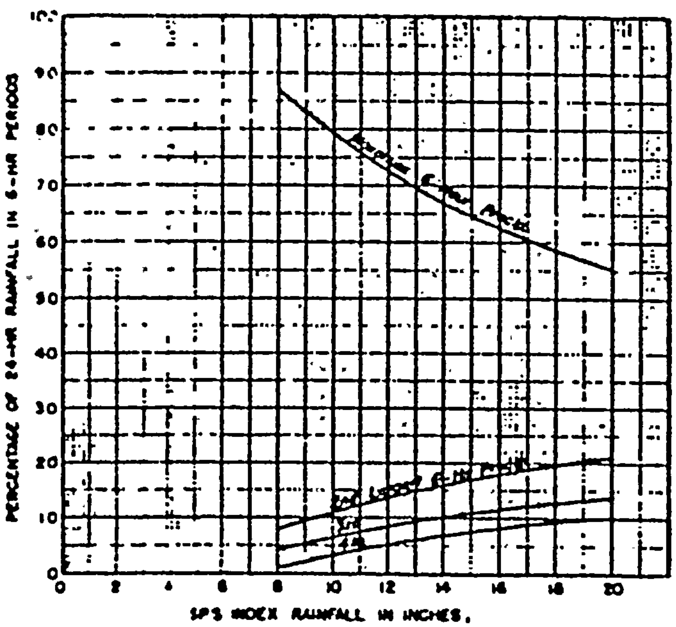

FIG (a) SPS 24-HOUR PRECIPITATION OVER 200 SQ MI vs PERCENT IN 6-HOUR PERIODS

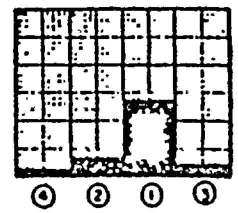

FIG. (b) TYPICAL ARRANGEMENT OF 6-HOUR RAINFALL QUANTITIES IN SPS

INDEX RAINFALL IN INCHES	PERCENTAGE OF 24 HOUR SPS RAINFALL IN DESIGNATED 6-HR PERIOD			
	④	②	①	③
1	2	3	4	5
8	10	80	870	40
9	21	95	830	54
10	32	110	792	66
11	43	12.3	759	75
12	53	138	725	84
13	61	149	626	94
14	70	160	669	101
15	76	170	645	10.9
16	81	179	624	116
17	88	189	603	120
18	91	197	585	127
19	98	203	568	131
20	10.1	21.0	551	136

FIG. (c) TABULATION OF DATA FROM FIG (a)

DEPARTMENT OF THE ARMY

CORPS OF ENGINEERS

STANDARD PROJECT STORM STUDIES
GENERALIZED ESTIMATES

TIME DISTRIBUTION
OF 24-HOUR SPS RAINFALL

PLATE NO 0

Figure 4. Time Distribution of 24-hour Standard Project Storm Rainfall

TIME DISTRIBUTION OF MAXIMUM 6-HOUR SPS RAINFALL

Rainfall Period (Sub-Division of 6-Hour Period)	Time Distribution of Maximum 6-Hour SPS Rainfall, Expressed in Percent of Total 6-Hour Rainfall — *Selected Unit Rainfall Duration, t_R			
	6-Hours	3-Hours	2-Hours	1-Hour
#1	#2	#3	#4	#5
1st	100	33	26	10
2nd		67	53	12
3rd			21	15
4th				38
5th				14
6th				11
TOTAL	100	100	100	100

*NOTE: The "selected unit rainfall duration," t_R is determined approximately from the synthetic unit hydrograph equation, $t_r = \frac{t_p}{5.5}$ in which "t_p" is the lag time from midpoint of unit rainfall duration, t_r, to peak of unit hydrograph, in hours, (See page 11, Engineering Manual for Civil Works, Part CXIV - Hydrologic and Hydraulic Analyses, Chapter 5 - Flood-Hydrograph Analyses and Computations). The following rounded-off values are to be used in the above table:

If t_p exceeds 16, use $t_R = 6$

If t_p is between 12 and 16, use $t_R = 3$

If t_p is between 6 and 12, use $t_R = 2$

If t_p is between 4 and 6, use $t_R = 1$

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Figure 5. Time Distribution of Maximum 6-hour Standard Project Storm Rainfall

... soil group, land use, and AMC, the time distribution of the SPF discharge was determined. This distribution is portrayed in Figure 6, from which the peak SPF discharge is seen to be 13,092 cfs.

SPF WATER SURFACE ELEVATIONS

The site cross-sections shown in Figure 7 were used by the HEC-2 computer code [6] to calculate the water surface elevation during the period of peak discharge. The Manning's Coefficients, which describe the "roughness" of the channel bed and bank and the shape of the channel were determined from direct observation, with specific values chosen for different reaches of the creek.[2] Other coefficients, which describe transitions between reaches and the bridge loss coefficients were described in detail previously.[2] Columns 1 and 2 of Table 1 show the water elevation vs. feet above the creek mouth. The section at the Culvert Bridge is at elevation 269.3, which is 0.7 feet below plant grade (270 feet).

Columns 1 and 2 of Table 2 show the water elevations at the Culvert Bridge (representative of the maximum site water elevation) for various flows. It is seen that a flow of 14,000 cfs results in a surface elevation approximating that of plant grade.

SPF Probability

The FRC report[1] discusses the flood probabilities and notes that an assumption of stationarity (no significant change in the interactions of the natural forces) is required in order to extrapolate the precipitation return period curve [2] beyond 500 years. This is, of course, true if the probability distribution over the long term is required. In our case we are not interested in the return period per se, but instead in the frequency of occurrence within the lifetime of the plant (expressed as probability per year). Over such a time frame, the assumption of stationarity is quite good. Accordingly, an extrapolation of available probability information, although imprecise by the nature of extrapolation, gives a qualitative interpretation to the precipitation frequency.

Based on the probability of occurrence of various 24-hour precipitation events, as shown in Figure 8[7], the probability that an 11.2 inch rainfall will occur in a given year is less than 10^{-6} (for such a small value, the probability of occurrence over the plant lifetime is equivalent to the annual probability multiplied by the lifetime in years).

COMPARISON WITH FRC ANALYSIS

Aside from the above discussion of probabilities, a number of differences exist between the analysis of this report and that of FRC.[1] First among these is the FRC choice of a 6-hour storm for the SPS, rather than the 24-hour storm. They declare that, "the peak flow almost certainly will be higher for a 6-hour storm that produces 6 inches of runoff than for a 24-hour storm that produces 12 inches." This declaration does not account for the time distribution of the 24-hour storm. In fact, inspection of Figure 4 reveals that the maximum 6-hour period within the 12-inch runoff 24-hour storm produces 8.7 inches of runoff, 45% more than the 6-inch runoff 6-hour storm. HEC-1 [4] was

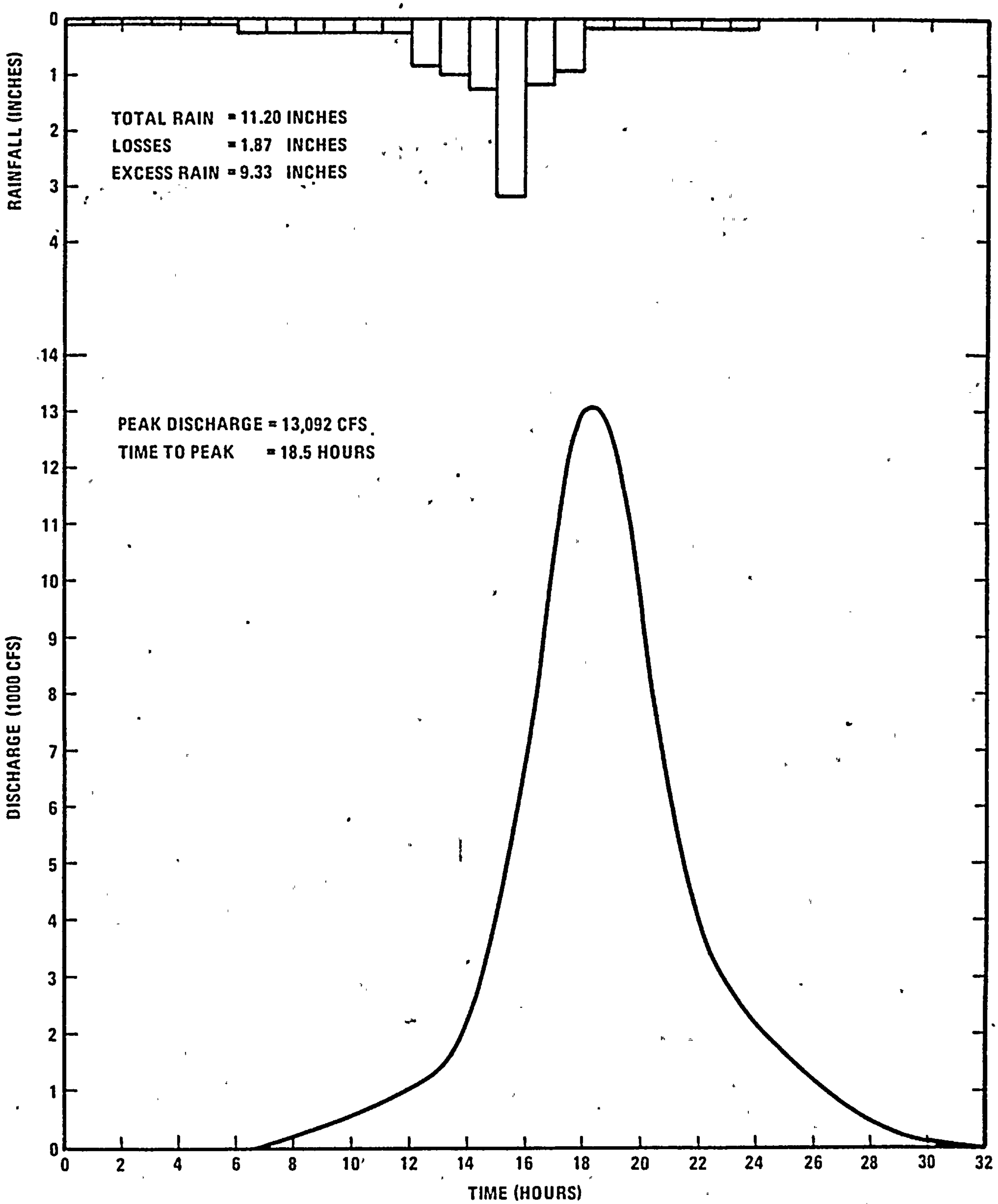

Figure 6. SPF Hydrograph

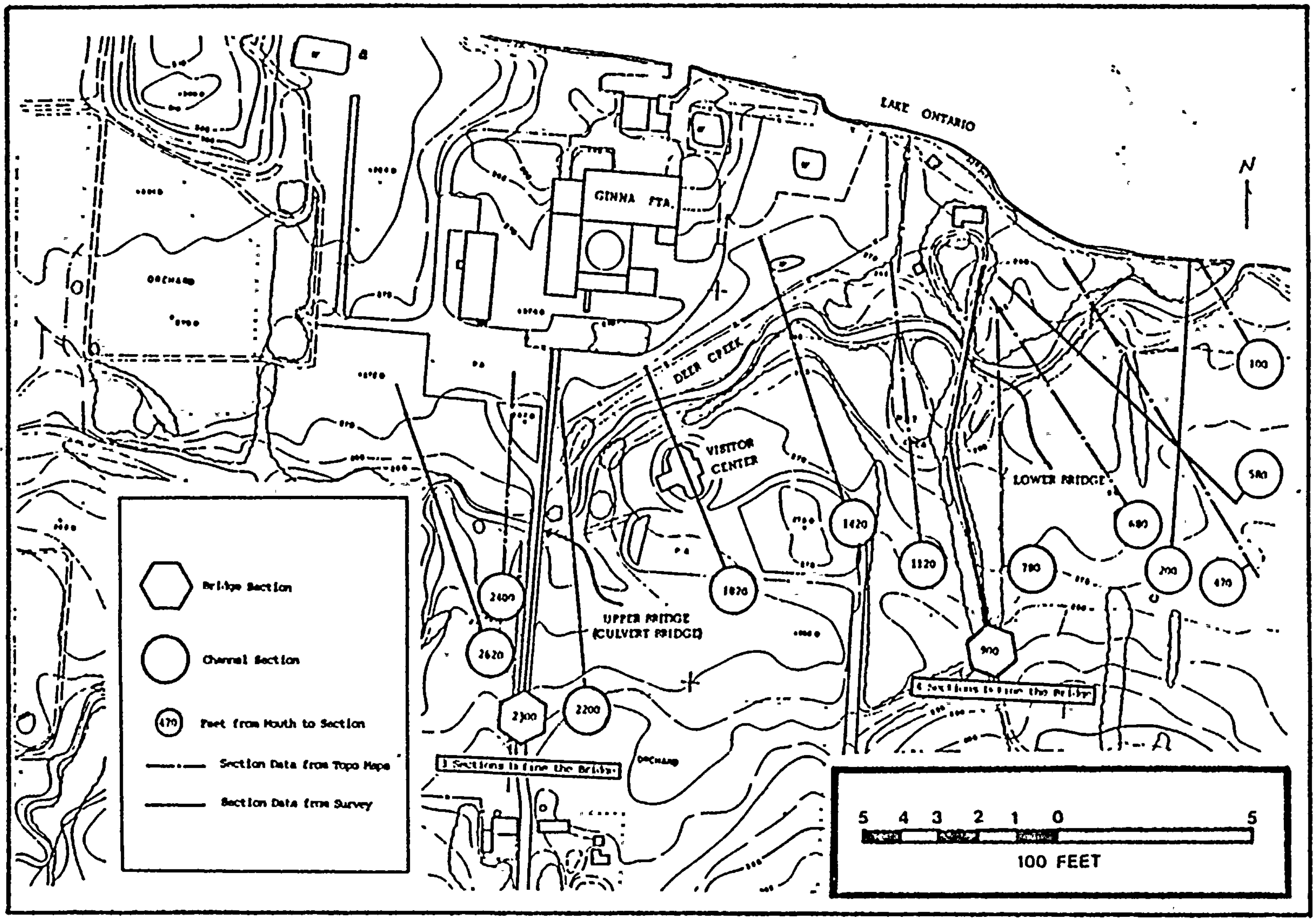

Figure 7. Location of Cross-sections Used for Backwater Calculations

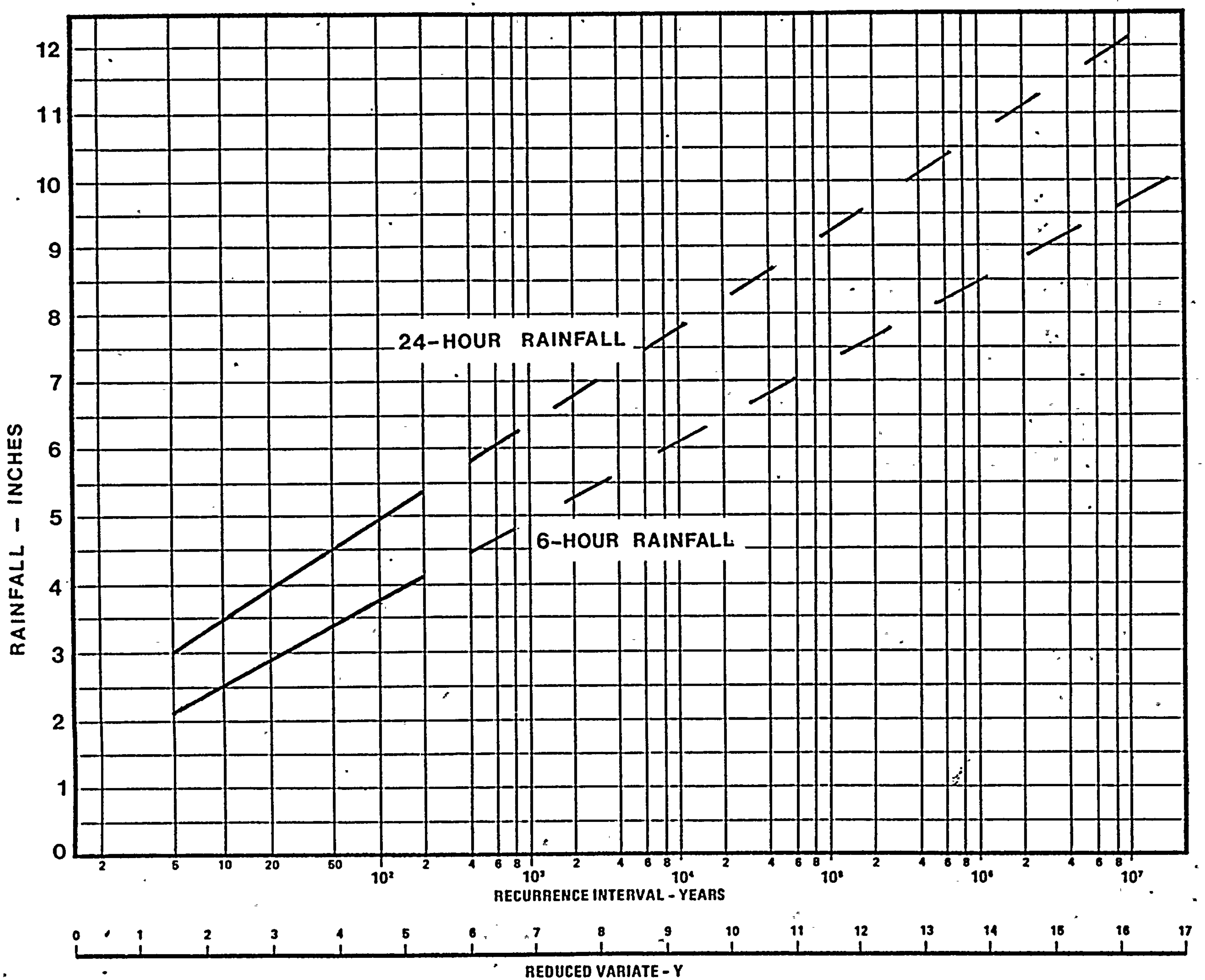

Figure 8. Return Periods for 6- and 24-hour Rainfalls

used to quantify this comparison. It was found that the peak discharges for the 6-inch 6-hour storm (CN=100, implying all precipitation is runoff) and the 12-inch 24-hour storm (CN=100) were 9,914 and 14,600 cfs, respectively.

FRC chose a 9-inch 6-hour storm as the SPS. We are not quite sure how this value was obtained, the 6-hour storm not being explicitly given in the document describing Standard Project Floods.(3) We do note that the probability of this storm is equivalent to the 11.2-inch 24-hour storm, as shown in Figure 8 (derived from information in reference 7). (This equivalence gives further credence to the efficacy of extrapolating the probability of occurrence.) Using all of the parameters and methodology described previously in this report, the peak discharge for the 6-hour SPS (9 inches) was calculated as 12,895 cfs. This value is comparable to the 13,092 cfs peak discharge for the 24-hour SPS (11.2 inches). Another major difference between these reports is FRC's choice of antecedent moisture condition III. Such a condition occurs, "when heavy rainfall or light rainfall and low temperatures have occurred during the 5 days previous to the given storm, and the soil is nearly saturated."(5) Although AMC III is certainly more conservative than AMC II, (average case for annual floods) its utilization with the SPS is questionable, having the effect of making a low probability event even more improbable. This decrease in probability can't be strictly quantified; nevertheless a factor of 10 seems reasonable (this is the approximate decrease corresponding to an increase in precipitation equivalent to the increase in runoff from the SPS for a change from AMC II to AMC III). The effect of the AMC choice is illustrated by considering the SPF with AMC II (CN=85), AMC III (CN=94), and total precipitation runoff (CN=100), resulting in peak discharges of 13,092, 13,914, and 14,112 cfs, respectively.

A further difference between the analyses is the FRC choice of constant overbank and channel Manning's Coefficients for the entire creek length. This contrasts with the varying coefficients used in this report, and described elsewhere, (2) which are based on direct observations of the basin. It is of note that no mention of FRC's modeling of the reach transitions and bridge constrictions is given. Assuming that they considered these effects in the same way as we, and using the SPF and cross-sections of our study, the effect of the change in Manning's Coefficients is an increase in water surface elevation at the Culvert Bridge of approximately six inches, as shown in Table 2.

The compound effect of the differences between the two analyses is illustrated in Table 1. Using FRC's SPF of 15,000 cfs (this contrasts with our calculation using FRC's parameters of 14,240 cfs) with their Manning's Coefficients results in water elevations approximately 1 1/2 feet higher in the area of the Culvert Bridge then would be the case with our SPF and Manning's Coefficients.

FRC does not show water surface elevations for any flood other than their "limiting flood" (12,000 cfs). Based on our modelling efforts, their elevations are too high. In fact, the elevations corresponding to FRC's SPF and Manning's Coefficients calculated by us were equivalent to the limiting flood elevations indicated in the FRC report. This may be due either to a mislabelling of their profile (i.e., their limiting flood may be their SPF) or a different characterization of land surface elevations.

REFERENCES

1. J.S. Scherrer et al, Hydrological Considerations Rochester Gas and Electric Corporation, R.E. Ginna Nuclear Power Plant, Technical Evaluation Report, Franklin Research Center, Philadelphia, PA, April 27, 1982.

2. NUS Corporation, Ginna Station Design Basis Flooding Study For Rochester Gas and Electric Corporation, Rockville, MD, August 1981.

3. Corps of Engineers, Standard Project Flood Determinations, EM 1110-2-1411 (Revised March 1965), Washington, D.C., March 26, 1962.

4. Corps of Engineers, HEC-1 Flood Hydrograph Package Users Manual, Davis, CA, September 1981.

5. Design of Small Dams, U.S. Department of Interior, Bureau of Reclamation, Water Resources Technical Publication, Washington, D.C., 1977.

6. Corps of Engineers, HEC-2 Water Surface Profiles Users Manual, Davis, CA, January 1981.

7. D.M. Hershfield, Rainfall Frequency Atlas of the United States for Durations From 30 Minutes to 24 Hours and Return Periods From 1 to 100 Years, Technical Paper 40, U.S. Weather Bureau, Washington, D.C., May 1961.

Conclusions

The FRC analysis choices for antecedent moisture condition and Manning's Coefficients are less realistic than those chosen for this analysis. Furthermore, it appears that the FRC calculation of limiting flood (12,000 cfs) water elevations is either incorrect or mislabelled. For these reasons, it is our belief that the results presented in this report are a more appropriate indication of flood flows and corresponding water elevations than are the results presented by FRC. It is our conclusion that the Standard Project Flood, using Standard U.S. Army Corps of Engineers methods, will not result in flooding of the Ginna Station.

TABLE 1

WATER SURFACE ELEVATIONS PROFILE FOR SPF

Water Elevation (ft)

Section Number (ft above mouth)	SPF (13,092 CFS)	FRC SPF (15,000 CFS) With FRC Manning's Coefficient
100	256.9	257.9
200	259.3	260.2
470	263.1	264.0
580	266.3	267.8
680	266.3	267.7
780	266.5	267.9
860	266.6	268.0
880	266.6	268.0
900	266.8	268.2
920	266.8	268.3
1120	266.9	268.3
1420	266.3	267.6
1820	266.1	267.8
2200	269.1	270.6
2280	269.2	270.7
2300	269.3	270.8
2320*	269.3	270.9
2400	269.3	270.8
2620	269.5	270.9

*Section at Culvert Bridge

Note: Both sets of elevations are results of NUS calculations.

[illegible]

TABLE 2

WATER ELEVATIONS AT CULVERT BRIDGE VS. DISCHARGE

Peak Discharge (CFS)	Water Elevation (ft) at Culvert Bridge: Present Report Manning Coefficient	Water Elevation (ft) at Culvert Bridge: FRC Manning Coefficient
10,000	267.4	267.9
11,000	268.0	268.6
12,000	268.7	269.2
13,000	269.3	269.8
14,000	269.9	270.3
15,000	270.4	270.9
16,000	271.0	271.4

Note: Both sets of elevations are results of NUS calculations.