Enclosure 1

TECHNICAL EVALUATION REPORT

HYDROLOGICAL CONSIDERATIONS

ROCHESTER GAS & ELECTRIC CORPORATION (SEP, II-3.A, B, B.1,

R. E. GINNA NUCLEAR POWER PLANT

NRC DOCKET NO. 50-244

NRC TAC NO. 41365, 41354, 41343, 41332

NRC CONTRACT NO. NRC-03-79-118

FRC PROJECT C5257

FRC ASSIGNMENT 16

FRC TASK 419

Prepared by

Franklin Research Center
20th and Race Street
Philadelphia, PA 19103

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FRC Group Leader: J. Scherrer

Prepared for

Nuclear Regulatory Commission
Washington, D.C. 20555

Lead NRC Engineer: G. Staley

April 27, 1982

Franklin Research Center
A Division of The Franklin Institute
The Benjamin Franklin Parkway, Phila., Pa. 19103 (215) 448-1000

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FOREWORD

This Technical Evaluation Report was prepared by Franklin Research Center under a contract with the U.S. Nuclear Regulatory Commission (Office of Nuclear Reactor Regulation, Division of Operating Reactors) for technical assistance in support of NRC operating reactor licensing actions. The technical evaluation was conducted in accordance with criteria established by the NRC.

Mr. J. S. Scherrer, Mr. J. Turner, Mr. W. Erikson, Ms. S. Roberts, and Mr. G. J. Overbeck contributed to the technical preparation of this report through a subcontract with WESTEC Services, Inc.

1. INTRODUCTION

1.1 PURPOSE OF REVIEW

The purpose of this review is to evaluate the assumptions, conclusions, and completeness of documentation in responses by the Rochester Gas and Electric Corporation (RG&E) to the U.S. Nuclear Regulatory Commission's (NRC) review of Systematic Evaluation Program (SEP) Topics II-3.A (Hydrologic Description), II-3.B (Flooding Potential and Protection Requirements), II-3.B.1 (Capability of Operating Plants to Cope with Design Basis Flooding Conditions), and II-3.C (Safety-Related Water Supply - Ultimate Heat Sink) for the R. E. Ginna Nuclear Power Plant. This review includes independent analyses by the Franklin Research Center (FRC) as needed to clarify or resolve issues. The NRC is reviewing other safety topics within the SEP and intends to coordinate an integrated assessment of plant safety after completion of the review of all applicable safety topics and design basis events (DBEs).

1.2 GENERIC BACKGROUND

The SEP was established to evaluate the safety of 11 of the older nuclear power plants. An important element of the program is the evaluation of the plants against current licensing criteria with respect to 137 selected topics, several of which relate to hydrologic assessments of the site.

In a letter dated January 14, 1981 [1], the NRC agreed to the SEP Owners Group's proposed redirection of the SEP, whereby each licensee would submit evaluations of 60% of the SEP topics in time for a review by the NRC staff to be completed by June 1981. Evaluations of the topics not selected by each licensee were the NRC's responsibility.

1.3 PLANT-SPECIFIC BACKGROUND

In a letter dated December 12, 1980 [2], the NRC submitted its evaluation of Topics II-3.A, II-3.B, and II-3.C to the Licensee. That assessment compared the R. E. Ginna Nuclear Power Plant against the criteria currently used by the regulatory staff for licensing new facilities. The Licensee was

instructed to inform the NRC whether the as-built facility differs from the licensing basis assumed in the NRC's assessment. The Licensee responded to the NRC's review in a letter dated January 28, 1981 [3] and identified new concerns, including discrepancies between the Licensee's findings and the NRC's assessment.

The NRC responded to the Licensee's concerns in a letter dated April 10, 1981 [4] incorporating additional information into their analysis of hydrologic issues. On May 1, 1981 [5], the Licensee responded to the NRC's reevaluation of SEP Topics III-3.A (Effects of High Water Level on Structures), II-3.A, II-3.B, II-3.B.1, and II-3.C. On August 18, 1981, the Licensee responded to the NRC's reevaluation in a letter containing an independent analysis of probable maximum flood (PMF) of Deer Creek [6]. An analysis and review of these outstanding topics is contained in this technical evaluation report.

2. REVIEW CRITERIA

The reference criteria used for all the hydrology topics were based on the Code of Federal Regulations, Volume 10, Section 50 (10CFR50), Appendix A, General Design Criteria, Overall Requirements, Criterion 2, entitled "Design Bases for Protection Against Natural Phenomena." Specific topic review criteria were taken from the following documents:

Standard Review Plan (SRP) [7].

- 2.4.1 Hydrologic Description
- 2.4.2 Floods
- 2.4.3 Probable Maximum Flood (PMF) on Streams and Rivers
- 2.4.4 Potential Dam Failures
- 2.4.5 Probable Maximum Surge and Seiche Flooding
- 2.4.6 Probable Maximum Tsunami Flooding
- 2.4.7 Ice Effects
- 2.4.8 Cooling Water Canals and Reservoirs
- 2.4.9 Channel Diversions
- 2.4.10 Flooding Potential Requirements
- 2.4.11 Low Water Considerations
- 2.4.13 Groundwater
- 2.4.14 Technical Specifications and Emergency Operation Requirements
- 3.4.1 Flood Protection
- 9.2.5 Ultimate Heat Sink

Regulatory Guides

- 1.27 Ultimate Heat Sink for Nuclear Power Plants [8]
- 1.59 Design Basis Floods for Nuclear Power Plants [9]
- 1.102 Flood Protection for Nuclear Power Plants [10]
- 1.127 Inspection of Water Control Structures Associated with Nuclear Power Plants [11]
- 1.135 Normal Water Level and Discharge at Nuclear Power Plants [12]

American National Standards Institute N170-1976

Standards for Determining Design Basis Flooding at Power Reactor Sites [13].

3. TECHNICAL EVALUATION

3.1 TOPIC II-3.A, HYDROLOGIC DESCRIPTION

3.1.1. Topic Background

This topic encompasses a definition of surface and groundwater regimes and their interface with plant safety-related buildings and systems. It provides a brief description of the hydrologic features of the site and surrounding area, including a definition of design basis conditions for plant features which were built to protect the plant from the consequences of hydrologic phenomena.

The information used to perform the reviews was gathered from the Licensee's files, NRC files, the U.S. Geological Survey, the U.S. Weather Bureau, and site visits. In some cases, detailed information was not available. In such cases, conservative estimates of expected hydrologic parameters required for analysis were presented.

3.1.2 Topic Review Criteria

The current criteria applicable to this topic are Standard Review Plan 2.4.1 [7] and ANSI N-170-1976 [13].

3.1.3 Evaluation

Hydrologic Description

Lake Ontario, on which the site is located, is about 190 miles long, 50 miles wide, a maximum of 780 ft deep, and covers about 7500 square miles. The average lake level, based on over 100 years of record, is 246 ft mean sea level (msl). The highest instantaneous still water lake level was 250.2 ft msl. Lake Ontario seldom freezes over, but ice occurs in the winter, usually along the southern and northern shores and in the northeastern end of the lake.

The surface of the land on the southern shore of Lake Ontario, at the site and east and west of it, is either flat or gently rolling. It slopes

upward to the south from an elevation of about 255 ft msl near the edge of the lake to 440 ft msl at Ridge Road (New York State Highway 104), 3.5 miles south of the lake.

There are no perennial streams on the site, but Deer Creek, an intermittent stream with a drainage area of about 13.3 square miles, enters the site from the west, passes south of the plant, and empties into the lake near the northeastern corner of the site. No original Deer Creek design basis flooding elevation has been identified for use in the review of hydrologic hazards at the Ginna plant site.

The main plant area and buildings are at grade elevation 270.0 ft msl; the north side of the turbine building and the river screenhouse are at elevation 253.5 ft msl. The plant grade entrances to the auxiliary building are at elevation 271 ft msl. The lowest limiting elevation of safety-related equipment in the sub-basement within the auxiliary building is 221.5 ft msl.

The plant is protected from surges and wind-driven waves by a revetment with a top elevation of 261.0 ft msl. All facilities necessary to shut down and to maintain safe shutdown are flood protected to a maximum stillwater level of 254.25 ft msl. The screenhouse floor is at elevation 253.5 ft msl, and the 0.75-ft curbs provide additional protection from potential exterior flooding. Additional flood protection is available in the screenhouse for the diesel generator buses, which are set 16 inches above the floor, and the service water pump motors which are set 24 inches above the floor. The diesel generators, which are located in the north side of the turbine building, are flood protected by steel curbs projecting 18 inches above elevation 253.5 ft msl [2]. The switchgear is located at elevation 253 ft msl and is protected by a 15-inch dam to elevation 254.25 ft msl.

3.1.4 Conclusion

There are no outstanding unresolved issues for SEP Topic II-3.A.

3.2 TOPIC II-3.B, FLOODING POTENTIAL AND PROTECTION REQUIREMENTS

3.2.1 Topic Background

The purpose of this topic is to identify the design basis flood level for the plant and site, under current licensing criteria, resulting from all potential flood sources external to the plant and site. The topic evaluates differences between the levels or values used for original design and construction and those derived under current licensing criteria. This evaluation includes the flood effects on safety-related structures, systems, and equipment. This evaluation also presents existing or proposed flood protection measures such as revetments, flood walls or doors, and emergency or administrative procedures.

The NRC's Regulatory Requirements Review Committee has specifically stated that all operating reactors must be evaluated for compliance with Regulatory Guides 1.59 [9] and 1.102 [10], including plants that began operation before those guides were issued. The guides are used to determine whether the facility design complies with current criteria or has some equivalent alternatives acceptable to the staff. The acceptability or nonacceptability of any deviations identified in this evaluation and the need for further action will be judged during the integrated assessment for this facility.

3.2.2 Topic Review Criteria

The following references were used as review criteria for this topic:

Standard Review Plan Sections 2.4.2, 2.4.3, 2.4.10, and 2.4.13 [7]
Regulatory Guides 1.59 [9] and 1.102 [10]
ANSI Standard N170-1976 [13].

3.2.3 Evaluation

Introduction

The specific topics discussed under SEP Topic II-3.B are as follows:

- A critique of the Licensee-supplied Deer Creek Flood Frequency Analysis

- A discussion of the likely historic discharge in the Deer Creek Basin
- A presentation of an independent PMF stage/discharge study
- A determination of local site flooding potential in the immediate plant area assuming an occurrence of the probable maximum precipitation (PMP)
- An evaluation of the appropriateness of the Licensee's original design basis groundwater elevation
- Conclusions reached in assessing the Ginna plant Lake Ontario surge protection structure
- A documentation of the need to identify the acceptability of present roof rainfall discharge systems to shed the PMP discharge.

Licensee-Determined Deer Creek Flood Frequency

An evaluation of the appropriateness of the Licensee's extrapolation of rainfall data [6] for the purpose of defining the frequency of the limiting flood (i.e., that flood which first jeopardizes safety-related equipment) is presented here.

The extrapolation of a time series of limited duration (i.e., less than 100 years) to derive recurrence intervals of greater than 500 years is a practice which deserves to be seriously questioned. Stationarity is assumed whenever probability theory is applied to model a time series. This assumption requires that there be no significant change in the interactions of the natural forces which produce the variate being extrapolated. The length of record for rainfall amounts used in Technical Paper 40 [14], which was published in 1961, is not sufficient to consider extrapolation into the 10^7 year range. Further, it should be recognized that much of the past rainfall data for the United States was obtained from non-recording rain gages which were read once each day by several thousand unpaid cooperative observers. Only comparatively recently have the much sparser networks of recording rain gages been available to provide details of duration of rainfall shorter than 24 hours. The once-every-24-hour rainfall information has provided an invaluable foundation for general hydrologic studies of the relationship between rainfall and runoff, but its use for other purposes requires caution.

The fact that rainfall data summarized by 24-hour periods are readily available in published form does not validate the assumption that the hydrologic behavior of every drainage basin, regardless of its size, can be adequately studied on the basis of 24-hour rainfall amounts. When the drainage area in question is as small as the 13.9 square miles of the Deer Creek drainage, use of 24-hour rainfall amounts may actually lead to erroneous conclusions about the safety of a given design.

Consideration of the time required for rainfall to show up in the stream bed as runoff and then to flow downstream and out of the drainage area will lead to an equilibrium time of 6 hours or less for so small a basin. Continuation of rainfall beyond 6 hours will result only in the replacement of water which has already left the drainage basin but not in a higher peak flow. 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. The short duration, high intensity rainfalls produced by giant thunderstorms may provide the critical peak flow for a small drainage but have a much different recurrence interval than the 24-hour amounts in the same area.

Historical Flood Record

It has been determined by both the NRC and the Licensee (and further within this report) that the occurrence of the PMF of Deer Creek results in water elevations above plant grade. The purpose of evaluating the plant's level of protection against the PMF is to demonstrate the acceptability of the site in accordance with present NRC licensing criteria. Present licensing criteria for new sites require that adequate protection be available to mitigate the consequences of the PMF. Consequently, the Ginna site is unacceptable when compared with present licensing criteria.

Further guidance on flood protection criteria, as referenced under the definition of SEP Topic II-3.B, is provided in 10CFR50, Appendix A, General Design Criterion 2 (GDC 2), "Design Bases for Protection Against Natural Phenomena." GDC 2 states the following:

> "Structures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena such as ...

floods, ... without loss of capability to perform their safety functions. The design basis for these structures, systems and components shall reflect: (1) appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated, (2) appropriate combinations of the effects of normal accident conditions with the effects of natural phenomena and (3) the importance of the safety functions to be performed."

Concern about subtopics (2) and (3) above has been expressed in earlier discussions of the effects of the PMF of Deer Creek. The following discussion of the historical flood record is provided in order to present a more enlightened account of the issues described under GDC 2, subtopic (1), "Consideration of the most severe of the natural phenomena..."

A systematic search for recorded annual maximum discharges from small uncontrolled and unurbanized watersheds in the Lake Ontario region produced the published records for numerous watersheds [15, 16]. The discharges shown for these maximum events give an indication of the expected largest discharges into Deer Creek when normalized to a per-square-mile basis. Table 1 contains a summary of the relatively larger floods from watersheds less than 50 square miles in size. Also shown in Table 1 is a list of normalized annual maximum discharges expressed in cfs per square mile of drainage area, length of historical record, and corresponding return periods of the maximum historic discharge. These normalized flood peaks are plotted on Figure 1 with their corresponding drainage areas.

Among the many gaged watersheds in the Lake Ontario region, eight were chosen for their similarity to Deek Creek. Mountainous and highly urbanized areas were not analyzed. Each of the streams has a drainage basin not larger than 50 square miles. Streams subject to large diversions or addition of water from outside the watershed were not used, nor were outlets from reservoirs or natural lakes, of which there are many in New York State. The Erie Canal runs approximately east to west through New York State near Lake Ontario, interrupting natural drainage patterns of several streams which were therefore disqualified from consideration. An effort was made to include

Table 1. Summary of Annual Maximum Flood Peaks from Watersheds in the Lake Ontario Region

	Drainage Area (sq mi)	Maximum Recorded Discharge (cfs)	Normalized Discharge cfs (sq mi)	Length of Record (years)	Return Period for Recorded Discharge
1. Cayuga Inlet near Ithaca, NY	35.2	4800	136.4	44	Tens of years
2. Oatka Creek at Warshaw, NY	41.9	4010	95.7	15	Hundreds of years
3. Stirling Creek at Stirling, NY	44.4	2370	53.7	24	Hundreds of years
4. Butternut Creek near Jamesville, NY	32.2	2820	87.6	23	Tens of years
5. Sugar Creek near Ossian, NY	9.8	1380	140.4	17	Tens of years
6. Sugar Creek at Guyanoga, NY	29.9	690	23.9	14	---
7. Terry Clove Kill near Pepacton, NY	14.1	4010	284.4	26	Hundreds of years
8. Cold Spring Brook at China, NY	1.5	335	223.3	34	Hundreds of years
Deer Creek Limiting Flood	13.9	12,000	863		
Deer Creek Standard Maximum Flood	13.9	38,700	2784		
Deer Creek Probable Project Flood	13.9	15,000	1079		

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records to the north, south, east, and west of Deer Creek. In addition, stations with the longest records were chosen wherever possible. To fulfill all these criteria, two partial-record stations (at which only high water levels are recorded) were included.

The return period associated with the maximum recorded flood peak at each station was determined on the basis of a log Pearson Type III analysis performed by the Albany office of the U.S. Geological Survey (USGS) [17]. Since the USGS did not calculate the return period for the maximum flood, its value has been approximated using a log-normal probability plot of the reported 2, 5, 10, 25, 50, and 100-year flood for each station. The generalized return periods for the maximum recorded floods are shown in Table 1.

Historical flood peaks were normalized with respect to contributing drainage area in order to demonstrate the variability in runoff from watersheds located in the same hydrologic province. The largest known runoff per square mile from drainages in the vicinity of the Ginna plant is 284.4 cfs/sq mile and was produced from the Terry Clove Kill watershed near Pepacton, New York. This watershed is located approximately 140 miles southeast of the Ginna site in the Catskill Mountains. For comparison, the limiting flood for Deer Creek at the Ginna plant has been determined here to be 12,000 cfs, which requires runoff in excess of 863 cfs/sq mile. Runoff of 2,784 cfs/sq mile will produce the peak discharge during the PMF of 38,700 cfs. For further comparison, the standard project flood (SPF) produces a discharge of 15,000 cfs. The SPF discharge presented here was determined using the Army Corps of Engineers "Standard Project Flood Determinations," EM 1110-2-1411 [32] (see Figure 1). This evaluation used a 6 hour-13.9 square mile standard project rainfall of 9 inches and a basin curve number of 94.

Peak discharge during the SPF occurs about 6.5 hours after rainfall begins and (for comparison) the limiting flood discharge is reached only 5.0 hours after precipitation starts.

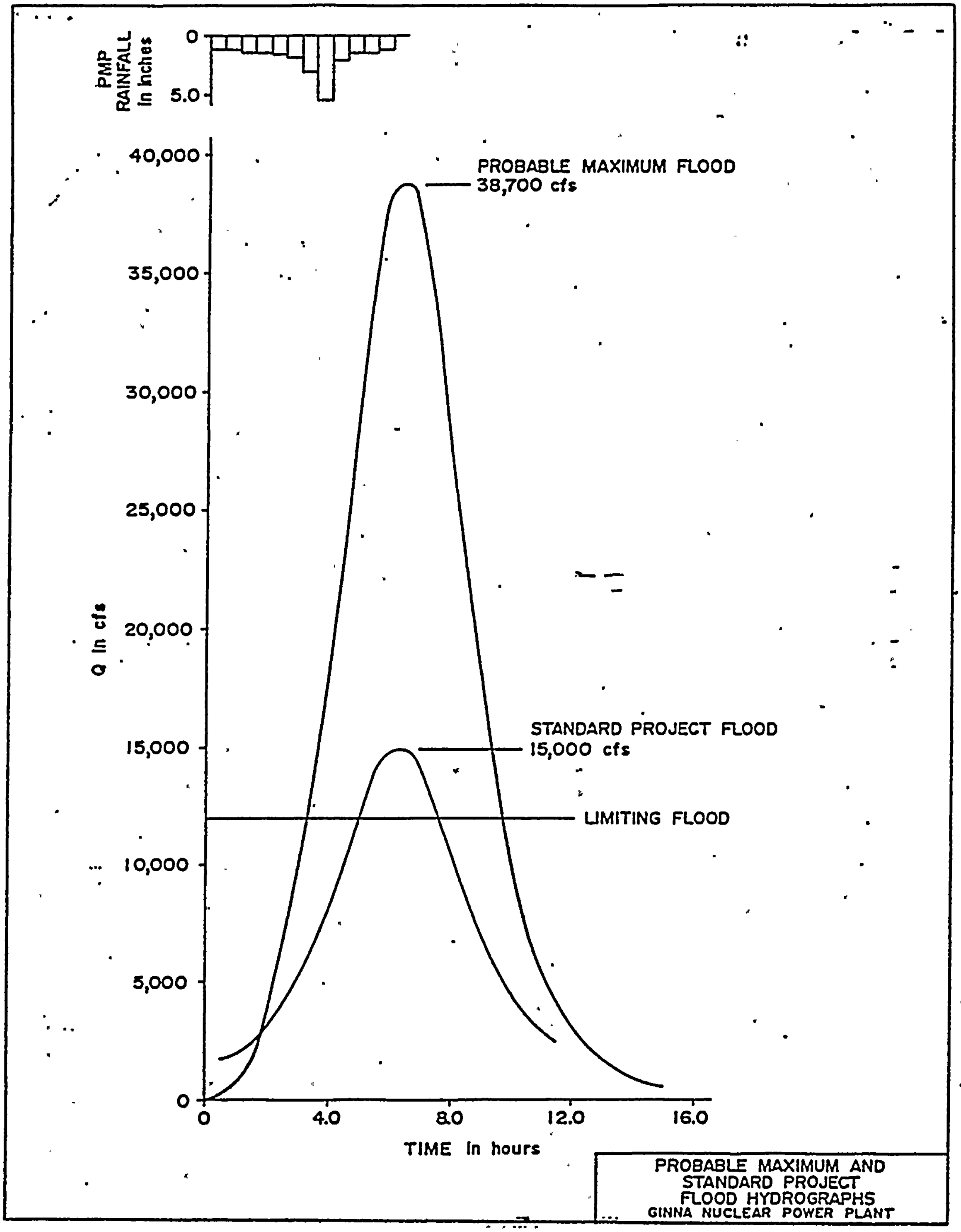

Figure 1. Probable Maximum Flood Hydrograph

Flooding of Deer Creek

The PMF for the combined Deer Creek and Mill Creek watersheds was simulated by the HEC-1 program [28]. This computer program uses the rainfall/runoff algorithm found in the Soil Conservation Service TR-20 model.

The HEC-1 model simulated the runoff from the 13.9-square-mile watershed based on assumed rainfall and watershed response functions. Rainfall amount and intensity were calculated using procedures outlined in HMR 51 [18] and the U.S. Army Corps of Engineers Standard Project Flood Determination [27]. The watershed response function was independently determined based on background information provided by the Licensee [6] and analytical methods presented by the Soil Conservation Service [30].

The duration of the PMP used in the watershed model is dependent upon the basin lag time or the time between peak rainfall and peak runoff. When the storm duration is much longer than the basin response time, the flood will theoretically reach maximum discharge prior to the cessation of rainfall. The additional rainfall will replenish the runoff volume while contributing little to the flood peak. Lag time for the Deer Creek watershed was calculated to be 2.6 hours; therefore, the rainfall duration should be of a similar length to assure an adequate degree of conservatism. The lag time determined for use in this report is in agreement with the value presented by the Licensee [6].

A 6-hour storm duration was selected as model input because it was the shortest storm length published for estimates of the PMP [18]. A longer storm length, such as the 24-hour storm simulated in the Licensee's report [6], would result in a smaller momentary maximum rainfall and runoff rate.

The 6-hour PMP for the south coast of Lake Ontario at the Ginna site is 23.5 inches over the watershed. The watershed size used in estimating the PMP was 10 square miles. It is recognized that this area is less than the actual 13.9-square-mile drainage, but the results will yield a more conservative estimate.

The watershed response function contained a lumped parameter, called a Curve Number, that is dependent upon soil type, land use, and antecedent

moisture. The soil type and land use classification for the Deek Creek watershed was based on values reported by the Licensee [6]. However, the antecedent moisture condition selected for use in this study is more conservative than the value assumed in the Licensee's earlier study. The change in antecedent moisture from antecedent moisture condition (AMC) II to AMC III resulted in an increase in the Curve Number from 85 to 94.

The simulated PMF for Deer Creek at the Ginna site, seen in Figure 2, has a maximum discharge of 38,700 cfs excluding any additional runoff due to base flow or groundwater inflow which can be as little as 2% of the PMF peak discharge. The hydrograph peak occurs at about 6.5 hours after rainfall begins or about 2.5 hours after the peak in rainfall intensity. Flooding of the plant site begins at about 12,000 cfs or less than 3.5 hours after rainfall begins.

Water Surface Profiles

The standard step method was used to calculated the stage discharge relationship for the Deek Creek. The computation was made using the 1981 version of the USCE, HEC-2 program [29], and CDC-7600 computer.

The geometric shape of the river channel was determined from the Licensee's 10-foot contour interval site map, No. SK447-93, and verified with the cross sections provided in the Licensee's report [6].

The locations of the representative cross sections used in the hydraulic analysis are shown in the plan view on Figure 3 where cross sections 3 and 8 represent the two bridges crossing the river channel.

Manning's roughness coefficients used in this study were 0.035 and 0.05 for the main river channel and overbanks, respectively. The n-value of 0.035 is representative of a natural stream consisting of a moderately straight and clean channel bottom. The n-value used to simulate the channel overbanks, 0.05, is representative of flood plain having scattered brush and heavy weeds [31]. So long as the main channel and overbank are cleared of debris and maintained in this condition through subsequent inspections, the Manning's

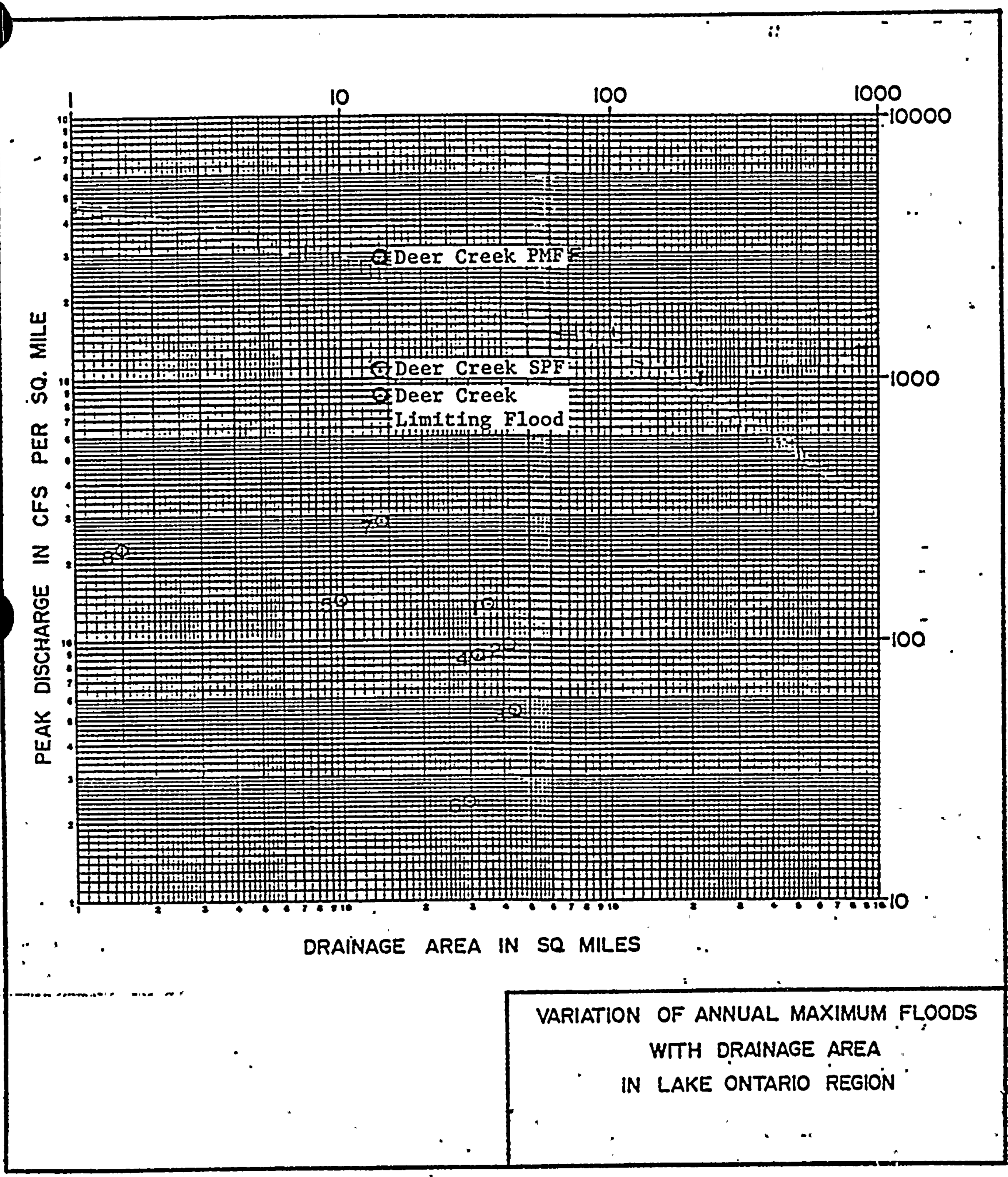

Figure 2. Normalized Annual Maximum Discharge for Watersheds in the Lake Ontario Region

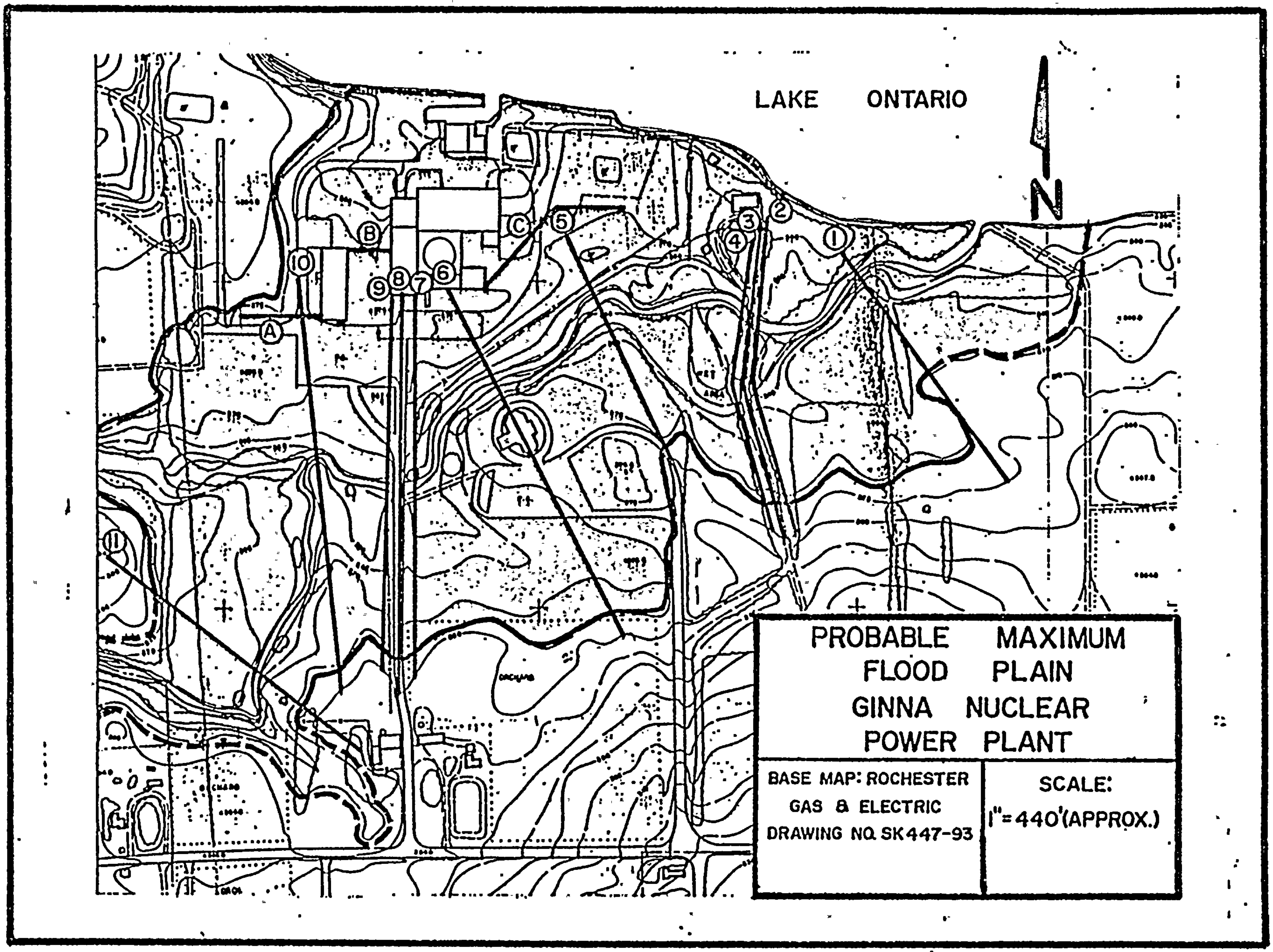

Figure 3. Probable Maximum Flood Plain

number assumed here is reliable. Changes from this condition would yield slightly higher or lower flood elevations for various stream discharges.

The hydraulic analysis produced a stage-discharge table for each cross section in the study reach. Based on these representative rating tables, the limiting flood at the power plant was found to be 12,000 cfs. This discharge would result in a water surface elevation at plant grade or 271 ft msl between cross sections 7 and 10 as seen on Figure 3. The limiting flood discharge is based on the assumption that the hill crest west of the auxiliary building is at plant grade. This assumption was verified by using RG&E drawing No. 33013-555 showing the proposed grade line between the containment building and the guardhouse and waterhouse as having a grade elevation of 270.7 ft msl.

At flows greater than 12,000 cfs, the flood waters leave the main river channel and travel overland to the lake. The hill crest west of the auxiliary building will be topped by flows in excess of 12,000 cfs. The hill crest to the east of the containment building will begin to be overtopped at flows greater than 19,000 cfs.

The calculations resulting in stage-discharge tables for the flood waters flowing northward over the hill crest were based on the geometric shapes of the three digitized cross sections identified as A, B, and C on Figure 4. Furthermore, it was assumed that the flow through these cross sections was hydraulic at critical depth. The water surface elevations and discharges passing selected cross sections during the PMF have been summarized in the table that follows. The depth of water at buildings at plant grade, represented by cross section 9, was calculated to be 4.4 ft above plant grade during the peak of the PMF of Deer Creek.

By combining and routing the waters flowing over the hillcrest, the depth of flow at the screenhouse was calculated to be 12 ft, with depths becoming more shallow toward Deer Creek. This calculation was based on the assumption that flow through the discharge canal mouth was 12 ft per second and that the sea wall acted as a broad-crested weir. In this case, the sea wall is the principal hydraulic control in the vicinity of the discharge canal. A PMF discharge of 13,200 cfs at the screenhouse, having a floor elevation of

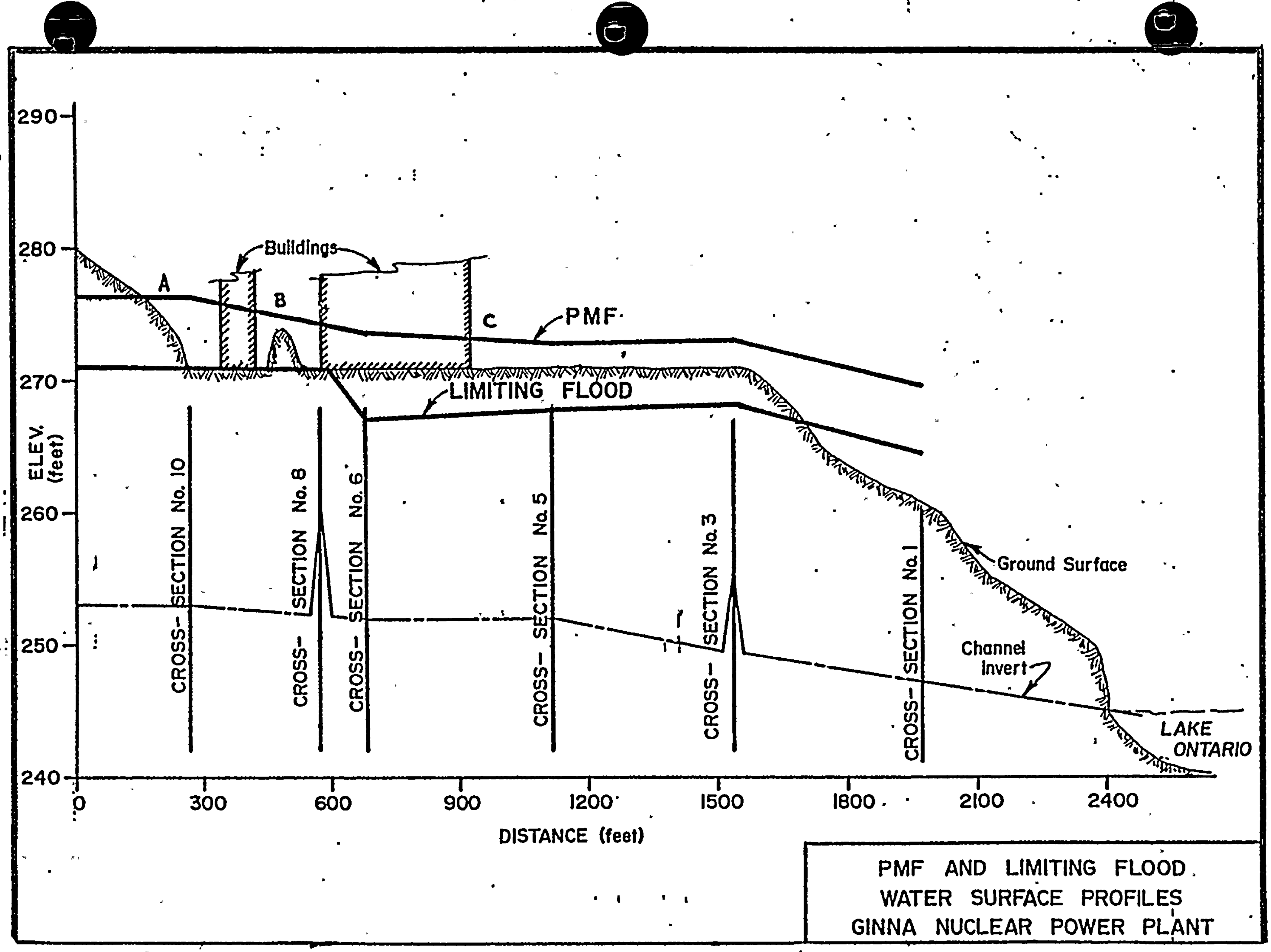

Figure 4. PMF Water Surface Profile - Limiting Flood Water Surface Profile

253.5 ft msl, would result in a water surface elevation in excess of 265.5 ft msl. The security fence placed on top of the sea wall will add considerable depth to the flood waters near the screenhouse; however, these calculations did not account for this blockage.

The PMF water surface elevations for selected safety-related locations are presented below and were determined using USCE, HEC-2 [29].

Section Number	Location	Elevation (ft msl)
8	SW corner of service building	275.4
6	Auxiliary building	273.6
5	East yard	272.8
—	Screenhouse	265.5

Windwaves were not included in calculations of PMF flood level. The short fetch length, with shallow depth over most of its extent, ensures that no significant waves can be generated. Trees around Deer Creek would interfere with windwave generation. Inspection of topographic maps reveals an area at the edge of the plant site where ground level rises above plant grade; this feature would cause waves to break before reaching safety-related structures and would prevent wave runup.

Local Site Flooding During the PMP

Independent evaluations were made by the NRC staff [2, 4] of the flood levels which would occur at safety-related buildings, assuming an occurrence of the local PMP on the immediate site area. Rainfall was assumed to occur in the immediate plant area and the resulting flow (runoff) assumed to move overland toward the discharge canal. Rainfall depths were obtained from Hydrometeorological Report No. 51 [18] for the 13.9-acre drainage area. The time of concentration and peak discharge of 400 cfs were computed with methods described in Reference 19. The flood water will pond to an elevation of about 254.5 ft msl at the north (lower) portion of the site in the vicinity of the screenhouse [2]. NRC concluded [4] that safety-related equipment would be

unaffected by local floods and that the plant would be able to withstand local flooding with no detrimental effects.

Groundwater

The design basis groundwater elevation for the screenhouse/emergency service water structure was 253.5 ft msl, and the design basis for all other safety-related structures was elevation 250 ft msl [3]. The design basis under current criteria should be ground elevation at the structure in question. This will vary from elevation 253.5 ft msl on the north side of the plant to about elevation 270 ft msl on the south side. No groundwater contour maps or well hydrographs have been submitted to justify using a lower groundwater level.

The original groundwater studies (and other site studies) were conducted for the Licensee by Dames & Moore in 1964-1965 [20]. A plot plan of rock surface and groundwater contours, dated October 29, 1964, shows the findings of the Dames & Moore site survey. The plot plan is reproduced here as Figure 5 and contains identification and differentiation of rock surfaces and groundwater contour elevations for contour lines near the plant.

A cross-sectional view, based on the Dames & Moore plot plan, along section A to A' depicts the relationship of bedrock, water table, and ground surface elevations (see Figure 6). Although it is true that the water table reaches 247 ft at the plant, it is also true that, according to the plot plan, the groundwater elevation is somewhat above 250 ft near the containment. No information is presently available to determine whether these groundwater elevations were the highest, average, or lowest elevations recorded during the site survey.

A review of regional precipitation data was conducted to ascertain whether the groundwater elevation was likely to be high or low during the time the site study was in progress.

The annual precipitation values (inches) and their departure from normal (based on 1931-1960 records) for four recording stations located in the Rochester area are given in Table 2.

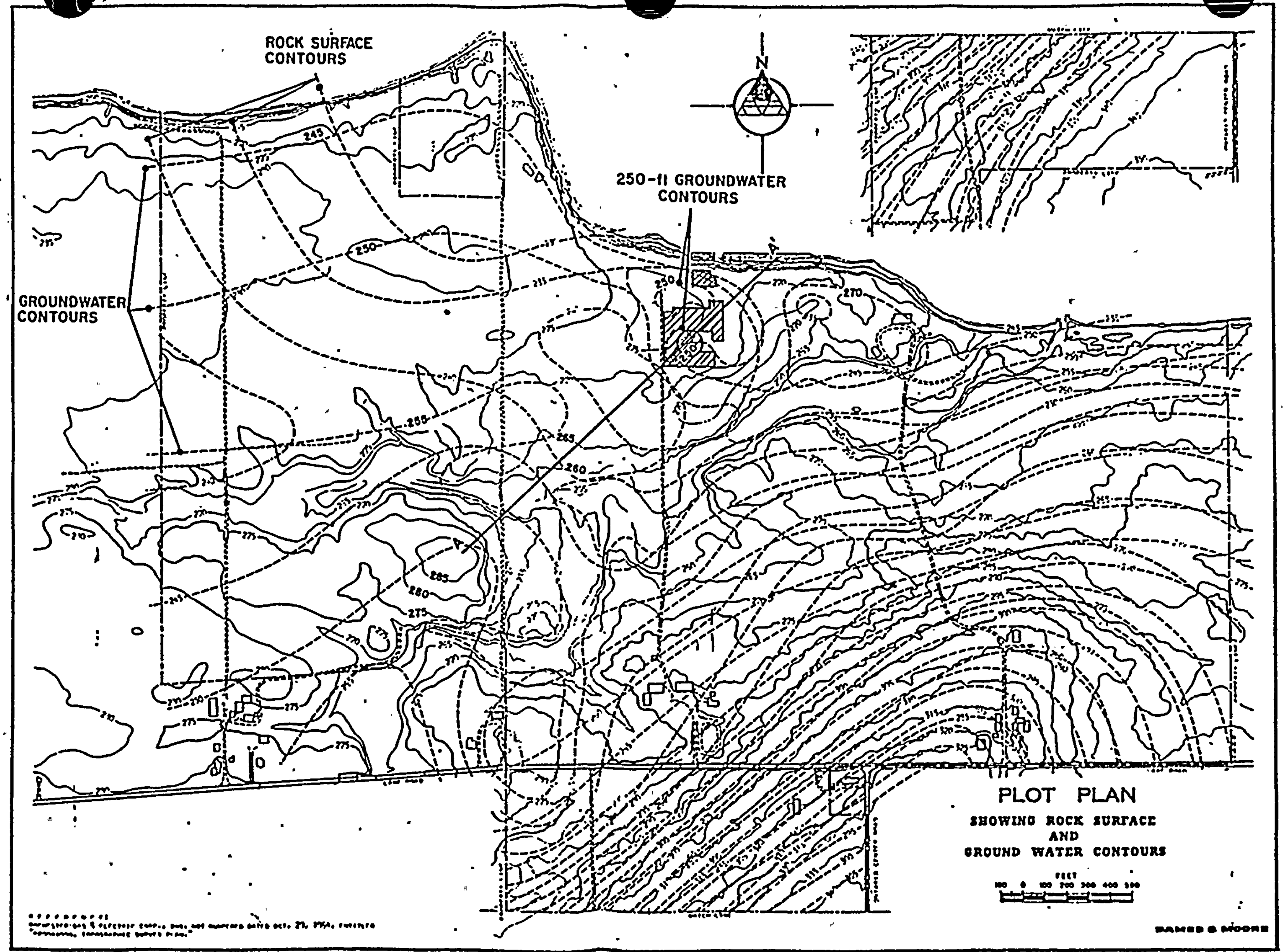

Figure 5. Plot Plan Showing Rock Surface and Groundwater Contours

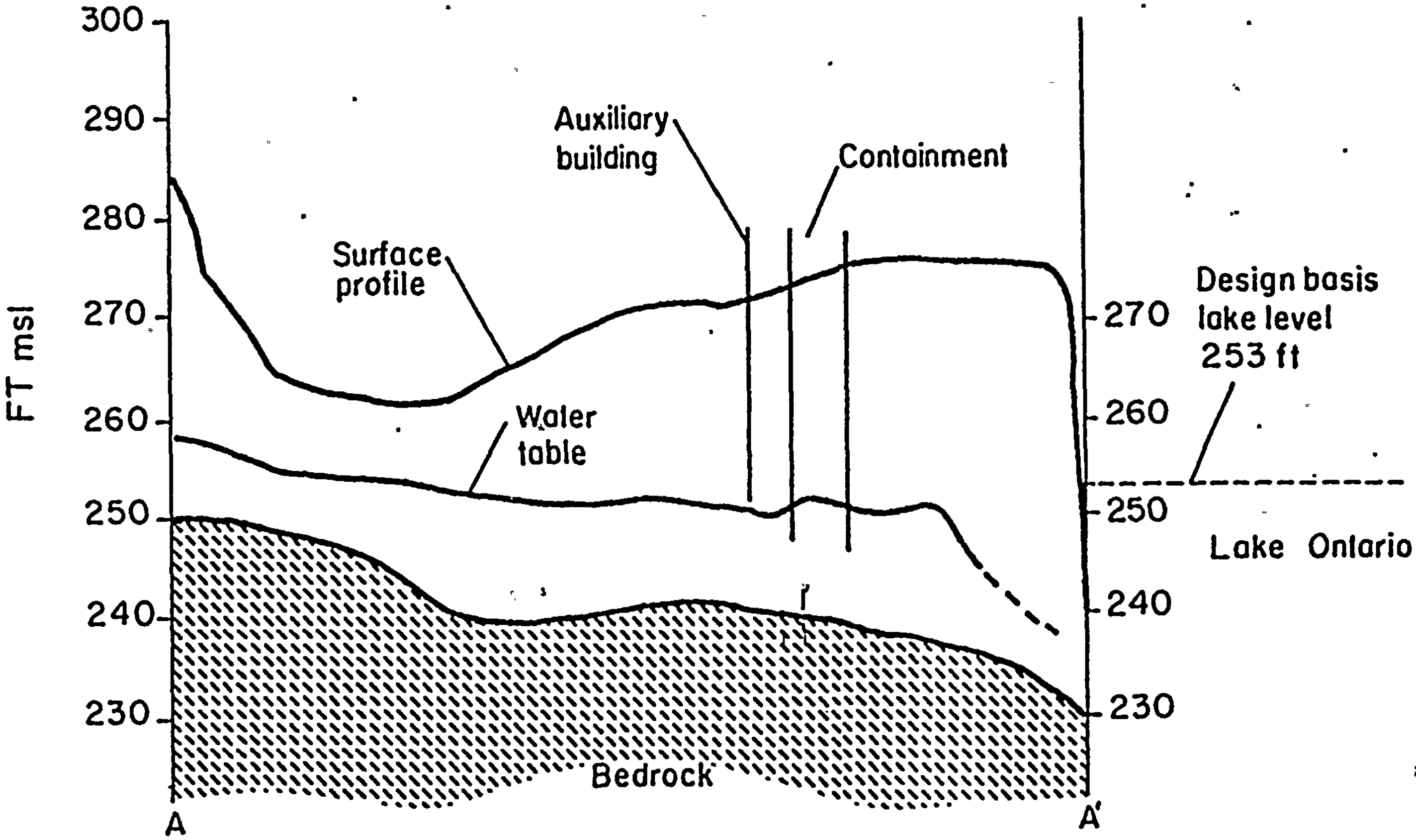

Figure 6. Sectional View of Ginna Plant Site Showing Bedrock, Zone of Saturation, and Surface Section A-A'

Table 2. Annual Precipitation Values for Four Recording Stations
Rochester, New York Area*

	Inches of Precipitation			
	Rochester Airport	Macedon	Brock-port	Sodus (Center)
1960				
Total	26.76	32.26	19.99	33.48
Departure	-5.07	-0.33	-	-
1961				
Total	30.51	33.51	29.98	39.87
Departure	-1.23	-0.92	-	-
1962				
Total	29.25	25.87	28.09	31.85
Departure	-2.25	-6.79	-	-
1963				
Total	24.09	27.28	20.90	29.55
Departure	-7.41	-5.38	-	-
1964				
Total	22.45	22.30	22.49	28.70
Departure	-9.05	-10.36	-	-
1965				
Total	25.16	30.42	25.56	34.01
Departure	-6.34	2.24	-	-

Note: A minus sign (-) connotes less than average annual precipitation. Normal based on 1931-1960 average.

* Source: Climatological Data, New York, U.S. Dept. of Commerce Weather Bureau, Annual Summary [21].

The following information is excerpted from Reference 21 to provide evidence that, both during and preceding the year in which the site survey was conducted by Dames & Moore, the annual precipitation throughout the state was below average and in many areas was considered to be the worst recorded drought. The comments that follow were made by the Weather Bureau State Climatologist in the form of a Special Weather Summary for each reporting period.

June 1963, New York State

"Growing drought conditions - Rainfall amounts were unusually light over most western areas, the St. Lawrence region, the Champlain region, and the Mohawk region....Amounts ranged under 1 inch over most sections immediately south and east of Lake Ontario. The Rochester area reported amounts under 1/2 inch....Following a dry season last year, and this season just about comparable in its deficiencies, groundwater tables have been further depleted."

October 1963

"October 1963 rates as an extraordinary month in the long annals of New York State weather records. It ranks among the very driest of months in the recorded history of weather in the Empire State. In addition to the severe lack of precipitation, the month was noted for unseasonable warmth and sunshine well above the normal expectancy."

"Precipitation: In nearly all sections of New York this October ranked very near or exceeded October of 1924 for record dryness."

"In records of more than 90 years at Buffalo and Albany, this month was second only to 1924 as the driest October of record."

"While in general the hydrologic effects of October's weather did not appear to be of record adversity in New York, streams, reservoirs, and wells were nevertheless seriously depleted of water supplies."

September 1964

"SEPTEMBER DRY ALL SECTIONS; NEW PRECIPITATION RECORDS SET: September precipitation was deficient over the Empire State for the second year in a row. It was generally drier than in September 1963 and, favored by warmer average temperatures, the amount of free-water evaporation was 30 percent greater (based on evaporation data at Ithaca). Over some 80 percent of the State's area, the monthly precipitation was from 2.0 to 3.5 inches below normal. Preliminary data indicate that above normal rainfall occurred at very few, if any, of the individual reporting stations."

November 1964

"THE SEVERE FALL SEASON DROUGHT OF 1964: The fall season of 1964 was one of the driest ever recorded in New York State. Not since 1930 has precipitation been so deficient during the autumn months over a major portion of the State. Areas affected by the fall drought in 1964 included not only the summer drought areas of the central, east-central, and southeast, but also most of the western and northern counties.

"Precipitation was well below normal in both September and October except in the extreme southwest (Chautauqua County) and eastern Long Island. Dry weather conditions intensified during the first half of November when precipitation shortages were even more pronounced, particularly in the southern half of the State. During the period of November 1-15, precipitation totaled generally less than 0.3 inch over the southern half with many southern tier and southeast sections receiving less than 0.15 inch."

June 1965

"There are 3 or 4 areas in which the combined rainfall for May and June has been especially deficient. In the lake plain along and south of Lake Ontario, the two-month precipitation has ranged from 20 to 30 percent of normal in Niagara, Orleans, Monroe, and western Wayne Countries, up to 35 or 45 percent of normal in the western and central Finger Lakes. Rochester has recorded the driest May and the second driest June in 130 years of record. The combined precipitation for May and June was only 1.13 inches, an amount typical of the shoreline counties."

Although it is not clear when the groundwater data were collected for the Dames & Moore report [20], the previously identified meteorologic conditions suggest that groundwater elevations were likely to be lower than normal during the period from fall 1963 to spring 1965. Thus, groundwater elevations identified on the site survey plot plan by Dames & Moore are likely to be non-conservative design basis elevations. Therefore, it is recommended that ground elevation (270 ft msl) be used as a conservative design review elevation.

Additional site boring logs were reviewed to determine the extent of groundwater fluctuation. These boring logs were developed during a site analysis conducted in June 1973, approximately 9 years after the original Brookwood site survey. Table 3 identifies the pertinent borings, the surface elevations at the locations of the borings, depth to groundwater from the surface, and consequent groundwater elevations given in feet above mean sea level (USGS datum).

Table 3. Resultant Groundwater Elevation Determined From Borings Taken West of the Ginna Plant in 1973

Boring Number	Surface Elevation USGS (ft msl)	Depth to Groundwater (ft) and Date Recorded	Groundwater Elevation USGS (ft msl)
101	279.3	19.3 June 21, 1973	260
102	274.4	13.5 June 26, 1973	260.9
103	275.4	18 June 14, 1973	257.4
104	289.2	23.9 June 15, 1973	265.3
106	285.4	19.2 June 29, 1973	266.2
208	281.2	25.1 April 24, 1973	256.1
210	280.3	27 May 2, 1973	253.3
A10	269.2	9.3 December 11, 1973	259.9
B2	275.6	17.1 November 27, 1973	258.5
C1	287.4	37.5 November 9, 1973	249.9

Figure 7 identifies the surface locations of 10 of these borings. Boring number A10 is approximately 500 ft west of the containment building, and boring number B2 is approximately 650 ft west of the containment building. Of the 10 borings identified in Table 3, these 2 borings are the closest to the Ginna plant.

These borings show that groundwater has exceeded elevation 250 ft msl, the design basis elevation, for locations near the Ginna plant. This information further demonstrates that the design basis groundwater elevation at the Ginna plant is likely to be non-conservative.

Lake Ontario Surge Flooding

As a condition of the Full Term Operating License, the NRC staff required the placement of additional shoreline erosion protection. This protection was added to ensure minimum wave overtopping of the concrete wall fronting the plant and lower water levels in the vicinity of the screenhouse.

Since some time has elapsed since the construction of the revetment, the NRC has performed an independent analysis, using procedures from the Shore Protection Manual [22], of the stability and present condition of the revetment fronting the plant site. The NRC concluded in its original Safety Evaluation Report [4] that, "If the revetment exists as designed, it would be capable of resisting surge flooding from Lake Ontario and therefore meets current regulatory criteria."

Subsequent inspections of the revetment by the NRC staff [23] and their consultant [24] showed that the revetment appears to be structurally sound and stable with no evidence of any major structure stability problems. Further, the inspections verified that the revetment has not degraded from the original design. Therefore, adequate protection from surge flooding exists at the Ginna plant.

Roof Drainage

The adequacy of roof drainage remains an open item within this report. The Licensee has not yet responded to NRC questions pertaining to these

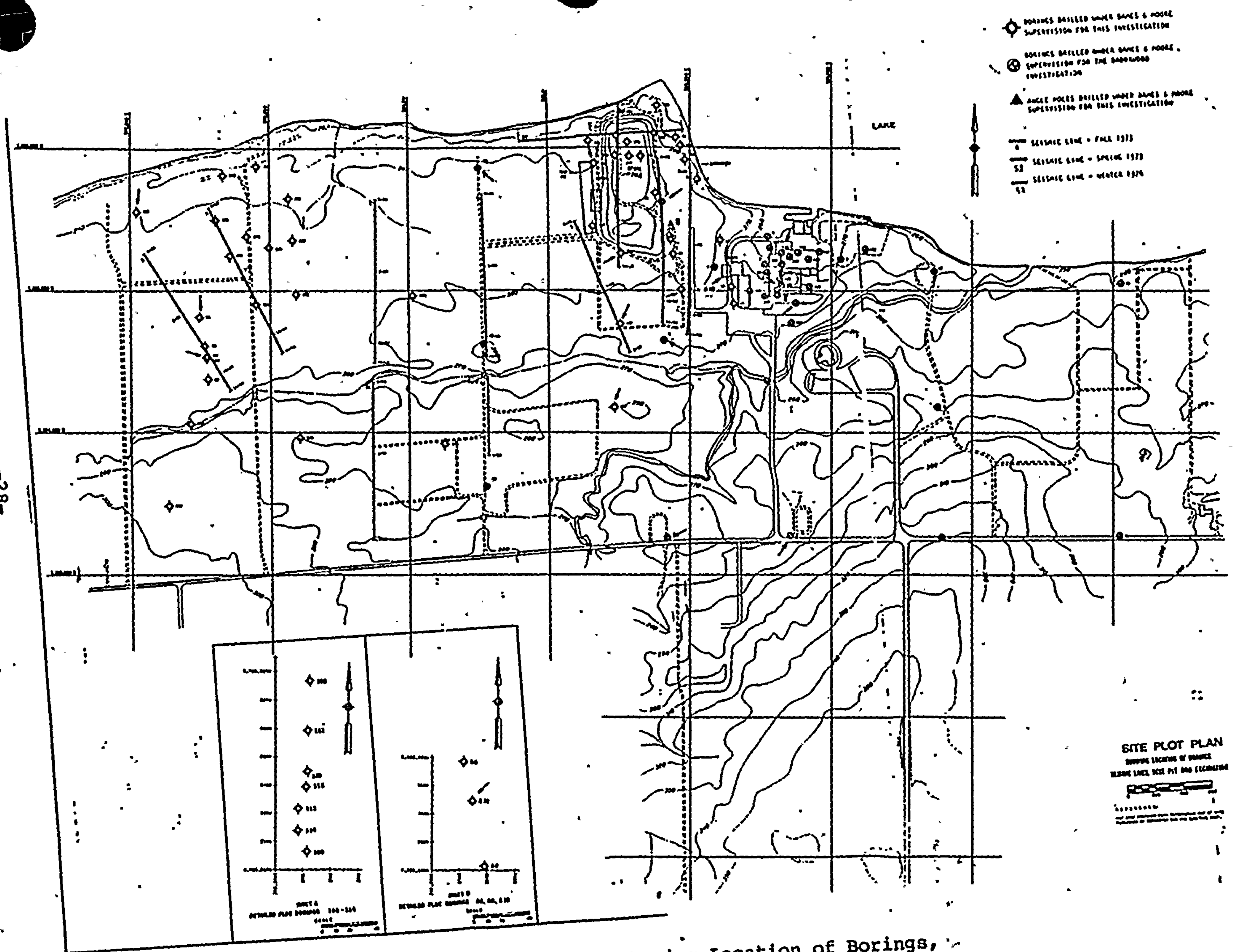

Figure 7. Site Plot Plan Showing Location of Borings, Seismic Lines, Test Pit, and Excavation

issues. The SEP Branch will address these issues with the Licensee in future meetings.

3.2.4 Conclusion

Flooding of Deer Creek

The PMF has been shown to exceed the elevations of the safety-related equipment at the Ginna plant (further information on this topic is presented in SEP Topic II-3.B1 within this TER).

The PMF discharge has been shown to be approximately 38,7000 cfs. The discharge associated with the limiting flood (i.e., that flood discharge which results in water rising to overbank conditions and affecting safety-related buildings) is approximately 12,000 cfs. The Ginna plant is presently protected from this flood discharge.

For reference, the maximum historical discharge that has been recorded on several basins in the Lake Ontario region is presented within this section of the TER.

Local Flooding

It is concluded that flood water will pond to an elevation of about 254.5 ft msl at the north area of the site in the vicinity of the screenhouse. As a result of RG&E's response in the January 28, 1981 submittal [3], it is concluded that the statements in the Ginna FSAR Section 2.6-10 are still valid and the paragraphs on pages 3 and 4 of the Topic II-3A, B, C evaluation regarding limiting equipment elevations are correct. According to the Ginna FSAR, Section 2.6-10, the limiting elevation for Class I equipment is elevation 253.5 ft (screenhouse floor elevation). Adding 0.75 ft for curbs around the screenhouse floor provides protection to elevation 254.25 ft. This is still below the predicted local flood level; however, the Licensee has verified that the limiting elevation of safety-related equipment is 254.8 ft msl (screenhouse floor elevation of 253.5 plus 1.3 ft to diesel generator buses 17 and 18). Therefore, safety-related equipment would be unaffected by

local floods, and the plant would be able to withstand local, immediate plant area flooding with no detrimental effects.

Groundwater

The design basis groundwater elevation at 250 ft msl is likely to be a non-conservative elevation based on a review of information provided by the Licensee. It is recommended that plant grade (elevation 270 ft msl) be used as the design review basis.

Due to annual and seasonal fluctuations of precipitation, the saturated zone of regolith and till located above bedrock could vary widely with groundwater elevation rising above the design basis elevation of 250 ft msl.

Input from SEP Topic III-3.A, Effects of High Water Level on Structures, should enable a determination of the consequences of an elevated groundwater table. Further, this topic should address the effects of these increased groundwater elevations as they affect the Ginna containment perimeter sump system. According to Reference 25, the NRC has identified no underdrain system at the Ginna plant. However, the perimeter sump system may be considered a dewatering system, and therefore should be shown to meet the Hydrologic and Geotechnical Engineering Branch, Branch Technical Position -1 (HGEB BTP-1), Safety Related Permanent Dewatering Systems, in order to satisfy the requirements of SEP Topic III-3.B. This evaluation is outside the scope of this review.

Lake Ontario Surge Flooding

According to References 4, 23, and 24, the revetment structure which protects the site from the probable maximum water level (PMWL) of Lake Ontario resulting from a probable maximum surge (PMS) conforms with present NRC licensing criteria and is in stable condition.

Roof Drainage

Roof drainage is an open item within SEP Topic II-3.B. Resolution is expected in the future.

3.3 TOPIC II-3.B.1, CAPABILITY OF OPERATING PLANTS TO COPE WITH DESIGN BASIS FLOOD CONDITIONS

3.3.1 Topic Background

The purpose of this topic is to ensure that emergency procedures and technical specifications which "harden"* the plant and protect it from flooding phenomena are identified and described. This section includes an evaluation of the adequacy of those procedures and discussion of any additional features needed to meet current criteria.

3.3.2 Topic Review Criteria

ANSI N170-1976 [13]

Regulatory Guide 1.59 "Design Basis Flood for Nuclear Power Plants" [9]

Standard Review Plan Sections 2.4.3, 2.4.4, 2.4.5, 2.4.7, 2.4.10, and 2.4.14 [7].

3.3.3 Evaluation

There are no existing emergency plans or technical specifications for the Ginna plant that relate to flooding from external sources, including the occurrence of a PMF on Deer Creek.

3.3.4 Conclusion

The SEP review of safe shutdown systems for the Ginna plant [26] identified the systems required to fulfill the BTP RSB 5-1 criteria. The systems are:

a. reactor protection
b. auxiliary feed system
c. main steam system (safety, isolation, and atmospheric dump valves)
d. service water system
e. chemical and volume control system
f. component cooling water system
g. residual heat removal system

*"Harden" = flood protection assumed to almost always be in place.

h. instrumentation for shutdown/cooldown
i. emergency power (ac and dc) and control power for the above systems and components.

The minimum systems list was generated with the assumption that the emergency diesel generators would be available to provide onsite emergency ac power. Two PMF studies [2, 6] have identified that the PMF level of Deer Creek exceeds plant grade (270 ft msl) by at least 5 ft. The emergency diesels, located in the turbine building, are at elevation 255.0 ft msl and would not be available due to ponding in the building once the flood exceeded 270 ft msl.

After the diesel generators are lost, the plant would be subjected to a complete loss of all ac current, an event not considered in the plant design basis. SEP Topic XV-24, Loss of All A-C Power, was deleted from the SEP program due to a duplication of efforts under Three Mile Island (TMI) NRC Action Plan. Although the plant may be able to mitigate the consequences of a complete loss of ac electrical power, the flooding results in the loss of other components required to reach and maintain a safe shutdown. Examples of these components and critical elevations are:

	Item	Protected to Elevation
Screenhouse	Diesel generator buses	254.9 ft msl
	Service water pump motors	255.5 ft msl
Turbine Building	Switchgear	254.25 ft msl
Auxiliary Building (at grade 271 ft)	RHR pump motors	221.5 ft msl
	SI pump motors	237.3 ft msl

In considering the above discussion, it is concluded that systems and components required to reach and maintain a safe shutdown are not protected from the effects of PMF conditions. The need for permanent flood protection structures, emergency procedures, or technical specifications to mitigate the consequences of the PMF on Deer Creek should be addressed during the integrated assessment of the facility. In general, it can be assumed that the time-dependent characteristics of the PMP that induce the PMF are such that all

prescribed emergency actions would need to be completed within a short period of time, on the order of 2 to 3 hours, with a maximum runoff occurring within an hour. Thus, on-the-spot sandbagging or similar emergency procedures are not considered technically feasible.

3.4 TOPIC II-3.C, SAFETY-RELATED WATER SUPPLY (ULTIMATE HEAT SINK)

3.4.1 Topic Background

This topic reviews the acceptability of a particular feature of the cooling water system, namely, the ultimate heat sink (UHS).

The UHS as reviewed under this topic is that complex of water sources, including necessary retaining structures (e.g., a pond with its dam or a cooling tower supply basin), and the canals or conduits connecting the source with, but not including, the cooling water system intake structures.

3.4.2 Topic Review Criteria

The review is based on current criteria contained in Regulatory Guide 1.27 (Rev. 2) [11], which is an interpretation of General Design Criteria 44, "Cooling Water," and General Design Criteria 2, "Design Bases for Protection Against Natural Phenomena," of Appendix A to 10CFR50. The NRC's Regulatory Requirements Review Committee has specifically stated that all operating reactors must be evaluated for compliance with the requirements of this regulatory guide to determine whether the facility design complies with current criteria or has some equivalent alternatives acceptable to the staff. The acceptability or non-acceptability of any deviations identified in this evaluation and the need for further action will be judged during the integrated assessment for this facility.

In addition to Regulatory Guide 1.27 [9], guidance is also contained in Standard Review Plans 2.4.11 and 9.2.5 [7], American National Standards Institute Standard N170-1976 [13], and Regulatory Guides 1.59 [9] and 1.127 [11].

3.4.3 Evaluation

The UHS for the Ginna plant is Lake Ontario. The inlet crib for the plant is on the lake floor about 3000 ft offshore. Water is conveyed from the crib to the screenhouse (intake structure) through a buried conduit. The circulating and service water pumps are located in the screenhouse.

The minimum mean monthly lake level of record for Lake Ontario at the Rochester, NY gage is elevation 243.0 ft msl. The lowest entrance level into the intake crib is elevation 217.0 ft msl. This 26-foot (243.0 to 217.0) depth of water at minimum lake level is more than adequate to accommodate the maximum setdown (negative surge) for this part of the lake, which is less than 5 ft. Lake Ontario meets the current regulatory criteria with regard to low water requirements.

The consideration of design basis temperature for safety-related equipment is only required where the supply may be limited or where the temperature or plant intake water from the sink may eventually become critical (e.g., ponds, small lakes, cooling towers, or other sinks where recirculation between plant cooling water discharge and intake can occur). This is not a consideration for the Ginna plant and Lake Ontario because the intake water is withdrawn from the bottom of the lake and the water temperature of this large lake is relatively stable.

3.4.4 Conclusion

Based on NRC analyses [4], the UHS complex meets current regulatory criteria with regard to flooding except for an occurrence of the PMF on Deer Creek. Flooding at the screenhouse would inundate both the service water and circulating water pumps. The seismic capability of UHS structures and conveyances is being reviewed in Topic III-6. The NRC staff review of the availability of cooling water from Lake Ontario indicates that the lake is an acceptable source for the safety-related water supply and UHS [4].

4. CONCLUSIONS

The following is a summary of conclusions regarding hydrologic assessments of the Ginna plant site.

Topic II-3.A

The information presented under SEP Topic II-3.A is complete.

Topic II-3.B

Flooding of Deer Creek

The Ginna plant site is not "flood dry" and is presently unprotected from the consequences of the probable maximum flood of Deer Creek. Consequently, the Ginna plant site does not satisfy present licensing criteria.

Further information has been provided in this TER which addresses three peripheral issues:

a. the consequences of the PMF
b. the present level of protection and
c. the likely maximum historical flood discharge of Deer Creek.

Lake Ontario Surge Flooding

The NRC has determined that the site is adequately protected from the effects of the probable maximum water level of Lake Ontario.

Groundwater

The design basis groundwater level at the Ginna plant has been stated by the Licensee to be 250 ft msl. Information obtained from the Licensee and other sources indicates that this may be a non-conservative design basis groundwater elevation and that the influence of groundwater rising to plant grade (270 ft msl) should be evaluated.

Local Site Drainage

The Ginna site has been shown to be adequate to shed the runoff resulting from the occurrence of the PMP on the immediate plant area [2, 4]. This item has been closed.

Roof Drainage

This issue remains unresolved.

Topic II-3.B.1

There are no existing emergency plans or technical specifications for the Ginna plant that relate to flooding from external sources. The need to develop emergency plans or technical specifications as a result of revised design basis flood levels should determined during the integrated assessment of the plant.

Topic II.3.C

Based on NRC analyses, the ultimate heat sink complex meets current regulatory criteria with regard to flooding except for an occurrence of the probable maximum flood of Deer Creek. The unresolved seismic capability of the ultimate heat sink conveyance structures is being addressed in Topic III-6.

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