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(2-76)

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TO: B.C. RUSCHE

FROM: NIAGARA MOHAWK POWER CORP.
SYRACUSE, N.Y.
G.K. RHODE

DATE OF DOCUMENT 9-29-76

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PLANT NAME: NINE MILE PT # 2

ENCLOSURE
RESPONSE TO REQUEST REGARDING THE REVETMENT DITCH SYSTEM.......

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(23 PAGES)

ACKNOWLEDGED

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NRC FORM 195 (2-76)

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NIAGARA MOHAWK POWER CORPORATION

NIAGARA MOHAWK

300 ERIE BOULEVARD WEST
SYRACUSE, N.Y. 13202

September 29, 1976

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U.S. NUCLEAR REGULATORY COMMISSION
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Director of Nuclear Reactor Regulation
Attn: Mr. Benard C. Rusche, Director
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Re: Nine Mile Point Unit 2
Docket No. 50-410

Dear Mr. Rusche:

Enclosed is information requested in Mr. Vassallo's July 16, 1976 letter regarding the Revetment Ditch System for Nine Mile Point Unit 2. Five copies of this information are provided which respond to Questions 3 and 7.

Portions of Response 7 contain information which is deemed proprietary under Title 10, Code of Federal Regulations, Section 2.790 by Stone and Webster, our architect engineer. This proprietary information will be transmitted under separate cover within the next few days.

Responses to Requests 1, 2, 4, 5 and 6 were previously submitted on September 9, 1976.

Very truly yours,

NIAGARA MOHAWK POWER CORPORATION

GERALD K. RHODE
Vice President - Engineering

10018

NLR/sz

Enclosure

Request 3

The grid spacing used in the analysis has not been shown to be adequately fine to produce conservative estimates of storm surge, particularly in the nearshore area. Verification studies revealed deficiencies in the model; these may be in part due to too coarse a grid. (Your referenced grid sensitivity analysis performed for a similar model used by Stone and Webster on Long Island Sound does not resolve the problem; the referenced review is incomplete.) No criteria for the choice of grid size has been presented by the applicant. It is our position that the grid size used in the model must be justified and shown to produce conservative results.

Response 3

The numerical simulation of storm surge using the two-dimensional storm surge model requires a grid system that closely approximates the water body where surge is to be simulated. The grid size is selected such that the numerical scheme produces an asymptotic surge with respect to grid size. The judgment of the investigator plays an important role in the final grid size selection. At the present state-of-the-art, a strict criteria for the choice of grid size used for numerical simulation of storm surge analysis has not been developed.

To demonstrate that a grid size in the order of 20,000 feet is reasonable in simulating the storm surge in Lake Ontario and at the plant site, a grid sensitivity analysis was performed by both increasing and decreasing the grid sizes. The grid size was first increased 50 percent to 30,000 feet and then reduced to 15,000 feet by splitting the coarser grid in half. Both grid layouts are shown in Figures 1 and 2, respectively. The 15,000 foot grid layout fits the land boundary of the lake more closely. Comparisons of computed surge heights using the 15,000 foot, the 20,000 foot, and the 30,000 foot grid sizes to historical data taken at Toronto, Oswego, and Cape Vincent during the storm of February 3, 1972, are presented in Figures 3, 4, and 5. The figures show that the simulated surges of different grid sizes follow each other very closely. The change of the grid size does not vary the nature of the fluctuations. These fluctuations could be due to the seiches at different modes caused by a moving wind field over an enclosed irregularly shaped water body. The maximum and minimum surges at various locations around the lake using the three different grid spacings are tabulated in Table 1. It should be noted that computer time increases about four times when the grid size is reduced by half.

The variations of extreme surges using these three grid sizes are less than 1.1 inches for all stations. The results show that the predicted surge fluctuates about a certain asymptotic value due to the numerical approximation, and a finer grid is not necessary to produce a significantly more conservative result. From this grid sensitivity analysis, it is concluded that the grid size in the neighborhood of 20,000 feet is adequate for surge simulations.

A sensitivity analysis of the three different grid sizes has also been applied to the Probable Maximum Wind Storm (PMWS). The surge heights for the 30,000 foot, the 20,000 foot, and the 15,000 foot grid

sizes are 2.8, 2.5, and 2.8 ft respectively. It should be noted that the grid point selected for the plant site with 30,000 foot and 15,000 foot grid size (Figures 1 and 2) is east of the grid point selected with 20,000 foot grid size. Since surge increases to the east end of the lake at the time of maximum surge, the increase in surge for larger and smaller grid sizes at the plant site is due to the location of the grid point used rather than the change of grid size.

Request 7

In order to adequately assess the model and the results obtained from it, we will require the computer runs including the program listing, input and output on a continuous, unseparated series of printout sheets. Provide computer runs for a PMWS case and for the February, 1972, verification storm.

Response 7

A. General Description (Non-proprietary Version)

The hydrodynamics of Lake Ontario during a large windstorm was represented by a two-dimensional mathematical model consisting of momentum and continuity equations in a vertically integrated form. The theory and numerical scheme of the two-dimensional mathematical surge model developed by Stone & Webster were detailed in the Response to the PSAR Request 2.34 (Reference 1) and the Topical Report SWECO 7501-P (Reference 2). To apply the model, the lake was schematized into an array of two-dimensional cells which were grouped into three zones as shown in Reference 3. Transient discrete wind and pressure information over the three zones for a storm were read into the computer. The wind shear stresses and pressure gradients over the lake were then calculated within each zone for each discrete time increment. The surge at each grid point was generated by solving the momentum and continuity equations by an implicit scheme with the wind shear stress and pressure gradient as the driving forces.

To facilitate the use of the two-dimensional surge program, a shear stress program and a pressure gradient program are used separately to read meteorological data and to calculate the driving forces of the wind stress and the pressure gradient. The outputs of these two programs are used as inputs to the two-dimensional storm surge model.

The wind shear stress program reads water body boundary geometry data, zoning information, and the transient wind speed and direction for different zones throughout the storm. The wind shear stress is related to wind speed by the wind shear stress coefficient. The formulation for the wind shear stress calculation was discussed in detail in Reference 1.

Similarly, the pressure gradient program reads water body geometry data, zoning information, and the transient atmospheric pressures at the zoning boundaries. The pressure gradient is taken to be the pressure difference divided by the length of the zone. In general, for the wind storm induced surge, the pressure gradient is considered a secondary factor as compared to wind shear stress. In addition, because the major axis of Lake Ontario is in the X- direction and the lake length is relatively larger than the width, the pressure gradient in the Y- direction is disregarded in all storm surge simulation.

Input data preparations and listings of all these programs are presented. It should be noted that the program listing for the two-dimensional storm surge model is identical to that of the topical report SWECO 7501-P except for a few minor changes identified with characters "L1" on the card number. Inputs and outputs for the February, 1972, storm and the PMWS case are included as requested. (All program listings are considered proprietary by Stone & Webster and due to the requirement to submit a continuous unseparated printout, are being transmitted separately.)

References (Response 7)

1. Preliminary Safety Analysis Report, Nine Mile Point Nuclear Station - Unit 2, Niagara Mohawk Power Corporation, Response 2.34, Supplement 10, 1973.

2. "Two-Dimensional Coastal Storm Surge Model," Topical Report SWECO 7501-P, Stone & Webster Engineering Corporation, 1975. Amendments 1, 2, and 3, 1976.

3. Niagara Mohawk Power Corporation Letter of September 9, 1976, from Mr. G. K. Rhode to Mr. D. B. Vassallo, Responses to NRC Requests of July 16, 1976. Response 2, Figure No. 1.

B. Input Data Preparation

B.1 Wind Shear Stress Program

B.2 Pressure Gradient Program

B.3 Storm Surge Program

B. Input Data Preparation

B.1 Wind Stress Program

Card 1	Title Card This card is used to identify the job. The information may be any alphanumerical characters from columns 1 to 80.
Card 2	STIME This card contains the incipient hour of a storm.
Card 3	NAMELIST/PARAM/ This card contains the information on the grid system and the distribution of the windfield.
NZONE	The number of zones in which the wind speed and the wind direction over the lake are assumed to be a constant at a specific time.
NUMMAX	The total number of continuous row-wise segments in the grid system. It is possible to have more than one segment in the same row in a system where the row is interrupted by an island or a peninsula.
NIFILE	The number of the disk file which the time of a storm and the induced wind stress over the grid system are stored.
NMAX	The total number of columns in the grid system.
MMAX	The total number of rows in the grid system.
NBD	An array that specifies the row number of each of the consecutive row-wise segments in the grid system.
NBDB	An array that specifies the row number of each of the first grid point in each of the continuous row-wise segments in the system.
NBDE	An array that specifies the column number of the last grid point in each of the continuous row-wise segments in the system.
NZZ	An array that specifies the number of the grid points in each zone for a constant wind speed in each of the continuous row-wise segments in the system.
RHO	The density of water.
Card 4	This card contains the time of a storm and the corresponding wind direction and the wind speed for each zone over the lake.

B.2 Pressure Gradient Program

Card 1	Title Card This card is used to identify the job. The information may be any alphanumerical characters from columns 1 to 80.
Card 2	STIME This card contains the incipient hour of a storm.
Card 3	NAMELIST/PARAM/ This card contains the information on the grid system and the distribution of the pressure over the lake.
NZONE	The number of zonal edges in which a constant pressure is described at a specific time.
NUMMAX	The total number of continuous row-wise segments in the grid system. It is possible to have more than one segment in the same row in a system when the row is interrupted by an island or peninsula.
NIFILE	The number of the disk file which the time of a storm and the induced pressure gradient over the grid system are stored.
NMAX	The total number of rows in the grid system.
MMAX	The total number of columns in the grid system.
NBD	An array that specifies the row number of each of the consecutive row-wise segments in the grid system.
NBDB	An array that specifies the column number of the first grid point in each of the continuous row-wise segments in the system.
NBDE	An array that specifies the column number of the last grid point in each of the continuous row-wise segments in the system.
NZZ	An array that specifies the number of the grid points in each constant pressure zone in each of the continuous row-wise segments in the system.
AL	The length of the grid size in feet.
Card 4	NAMELIST/POINT/ This card specifies the column numbers where the atmospheric pressures are specified.

Card 5	This card contains the time of a storm and the corresponding pressures at the zonal boundaries.

B.3
STORM SURGE PROGRAM

Card 1	Title Card This card is used to identify the job. The information may be any alphanumerical characters from columns 1 to 80.
Card 2	NAMELIST/CONTRL/ This card describes the system characteristics and the control parameters.
NMAX	The total number of rows in the grid system. In each grid system, allow at least one more row at each boundary in addition to the actual physical boundary in the model. In other words, the row number of the boundary in the lower border starts with 2, and that in the upper boundary ends with NMAX-1.
MMAX	The total number of columns in the grid system. The same restrictions previously described for NMAX also apply for MMAX.
ANGLAT	Latitude in degrees of the center of the grid system. This term is used in the determination of the Coriolis parameter.
AL	Grid size (ft)
AG	Gravitational acceleration, normally 32.2 (ft/sec^2).
AT	One half of a time step (sec). AT is thus the time interval used for each of the two operations.
NI	Number of iterations for the computation of the nonlinear water level in the continuity equation. It is generally taken as 1, that is, the nonlinear terms in the equation are evaluated at the lower time level.
SEINV	Initial value of the water level of the whole system. Zero is normally used.
NPRINT	Number of time steps in which a printout of water level of the entire system is desired.
NUMMAX	Total number of continuous row-wise segments in the grid system. It is possible to have more than one segment in the same row in a system where the row is interrupted by island or peninsula.

MUMMAX	Total number of continuous column-wise segments in the grid system.
N0MAX	Number of row-wise open boundaries in the grid system.
NTIDE	Number of time steps in which the computation will be performed. Thus, the total length of simulation time is determined by 2*(NTIDE-1)*AT.
Card 3	NAMELIST/STOUP/ This card specifies the option of providing a detailed analysis on a small scale system in a near shore area. The analysis is performed by making two separate runs. The first run is made on a larger area which includes not only the area of analysis, but also extends the lower boundary to the continental slope. The computed water levels at the locations along the boundary of the small system are stored on a magnetic disk or tape (code 33). The second run is then performed on the small system in which the water levels generated in the first run are applied at the open boundary as a given function of time.
N0ST0	Number of grid points at which the water levels are to be stored on a tape during the performance of the first run. Set N0ST0-0 if it is the second run or if no data are to be stored in a first run.
NST0	An array specifying the row numbers of the grid points where data are to be stored.
MST0	An array that specifies the column numbers of the grid points where data are to be stored.
ISW	Number of grid points at which the water levels are obtained from a tape in the performance of a second run. Set ISW-0 for the first run.
IFAC	The ratio of the grid size of the first run to that of the second run. The ratio must be an integer.

Card 4	NAMELIST/SETUP/ This card specifies the locations at which the surge hydrographs are to be stored on a magnetic tape. The tape will be used subsequently for Calcomp plotting.
NOSE1	Number of grid points at which the surge hydrographs are to be stored.
NSET	An array specifying the row numbers of the locations where the hydrographs are desired.
MSET	An array specifying the column numbers of the locations where the hydrographs are desired.
Card 5	NAMELIST/SOURCE/ This card specifies the locations and the discharge of the sources/sinks.
NOQS	Number of places where the sources/sinks are located.
NQS	An array specifying the row numbers of the grid points where the sources/sinks are located.
MQS	An array specifying the column numbers of the grid points where the sources/sinks are located.
QS	Discharge in cfs at each source or sink point.
Card 6	NAMELIST/BOUND/ This card is used to describe the structure of the grid system for the water body.
NBD	An array that specifies the row number of each of the consecutive row-wise segments in the grid system.
NBDB	An array that specifies the column number of the first grid point in each of the continuous row-wise segments in the system.
NBDE	An array that specifies the column number of the last grid point in each of the continuous row-wise segments in the system.
NBDIND	An indexing array describing the status of each of the row-wise segments in the system in regard to its role as a boundary. NBDIND = 99, if the entire segment is an open boundary. = 0, if the first and last points of the segment are both closed boundaries. = 10, if the first point is an open boundary and the last point is a closed boundary.

= 1, if the first point is a closed boundary and the last point is an open boundary.

= 11, if the first and last points are both open boundaries.

MBD	An array specifying the column number of each of the continuous column-wise segments in the system.
MBDB	An array specifying the row number of the first grid point in each of the continuous column-wise segments in the system.
MBDE	An array specifying the row number of the last grid point in each of the column-wise segments in the system.
MBDIND	An indexing array describing the status of each of the column-wise segments in the system in regard to its role as a boundary. See NBDIND for the description of the status.
Card 7	NAMELIST/NVALUE/ This card describes the bottom roughness coefficients in terms of Manning's n.
CIN	An array specifying Manning's n values for the whole system. The values are read in serially from left to right through successive row segments. Values within a row segment span from NBDB to NBDE. The row segments are ordered from left to right on each row and from the bottom to the top of the grid.
Card 8	NAMELIST/PATCH/ This card describes water depth values occurring on the left and lower land boundaries.
H	An array which is patched into the depth array for use within the program.
Card 9	NAMELIST/DEPTH/ This card describes the depth values of the whole system.
HIN	An array that specifies the depth of the whole system. Refer to CIN. Values are assigned in the same manner as CIN values.

The following information was read from disks.

TIM	The time of a storm from the shear stress program.
TIM	The time of a storm from the pressure gradient program.
TSX, TSY	From the shear stress program
TSX	An array containing the wind shear stress in the X direction for the whole system.
TSY	An array containing the wind shear stress in the Y direction for the whole system.
DPDX, DPDY	From the pressure gradient program
DPDX	An array containing the pressure gradient in the X direction for the whole system.
DPDY	An array containing the pressure gradient in the Y direction for the whole system.

C. Program Listing

C.1 Wind Shear Stress Program

C.2 Pressure Gradient Program

C.3 Storm Surge Program

(This program listing is a portion of submittal 3, dated September 28, 1976 and is considered proprietary by Stone & Webster.)

D. Sample Input

D.1 February 03, 1972 Storm

D.1.1 Wind Shear Input

D.1.2 Pressure Gradient Input

D.1.3 Surge Input

D.2 PMWS Case

D.2.1 Wind Shear Input

D.2.2 Pressure Gradient Input

D.2.3 Surge Input

E. Sample Output

E.1 February 03, 1972 Storm

E.1.1 Wind Shear Output

E.1.2 Pressure Gradient Output

E.1.3 Surge Output

E.2 PMWS Case

E.2.1 Wind Shear Output

E.2.2 Pressure Gradient Output

E.2.3 Surge Output

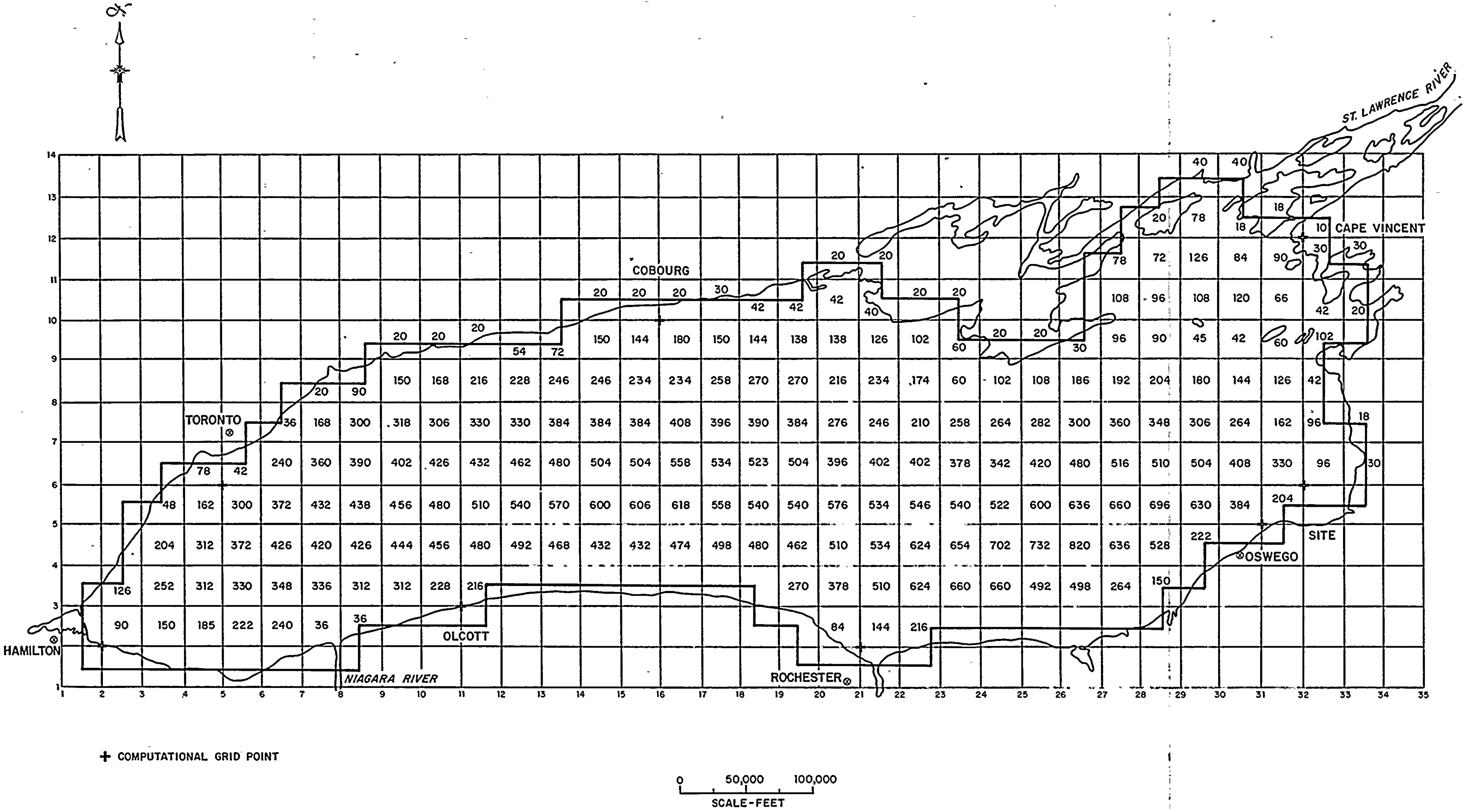


FIGURE 1
LAKE ONTARIO-
MATHEMATICAL MODEL
BOUNDARIES AND GRIDS
30,000 FT. GRID SPACING

NINE MILE POINT NUCLEAR STATION-UNIT 2
NIAGARA MOHAWK POWER STATION

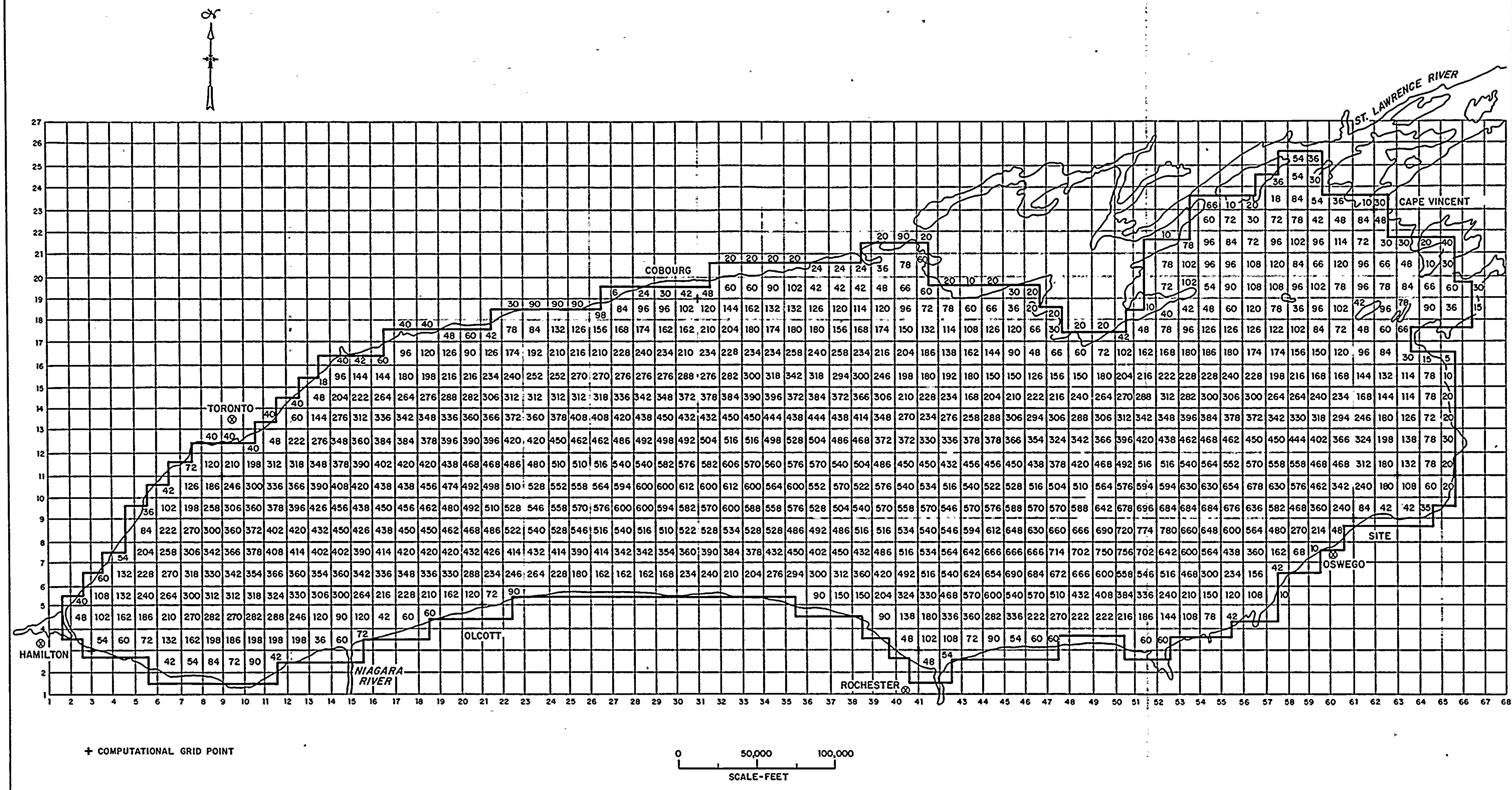


FIGURE 2
LAKE ONTARIO–
MATHEMATICAL MODEL
BOUNDARIES AND GRIDS
15,000 FT. GRID SPACING

NINE MILE POINT NUCLEAR STATION-UNIT 2
NIAGARA MOHAWK POWER STATION

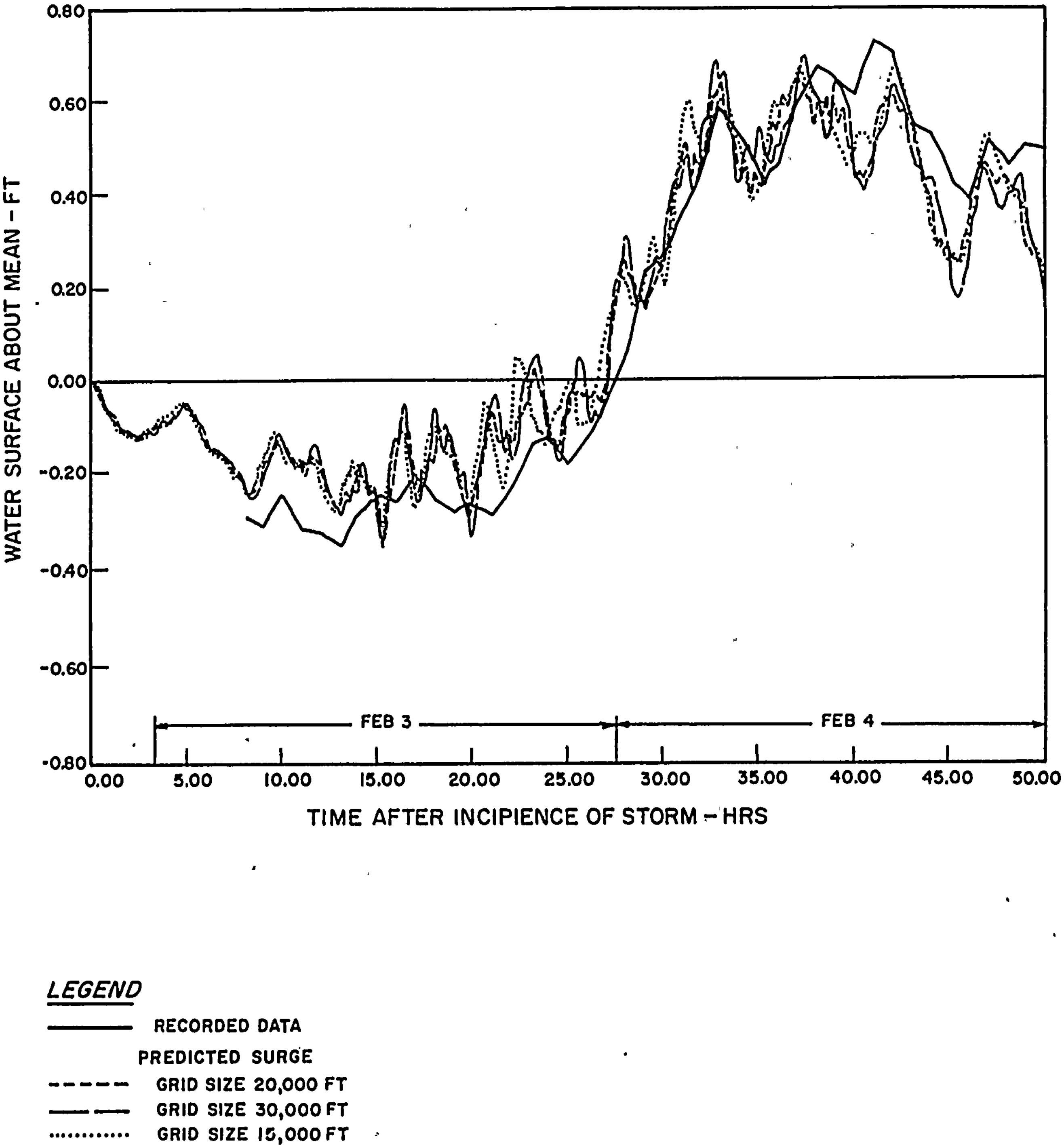
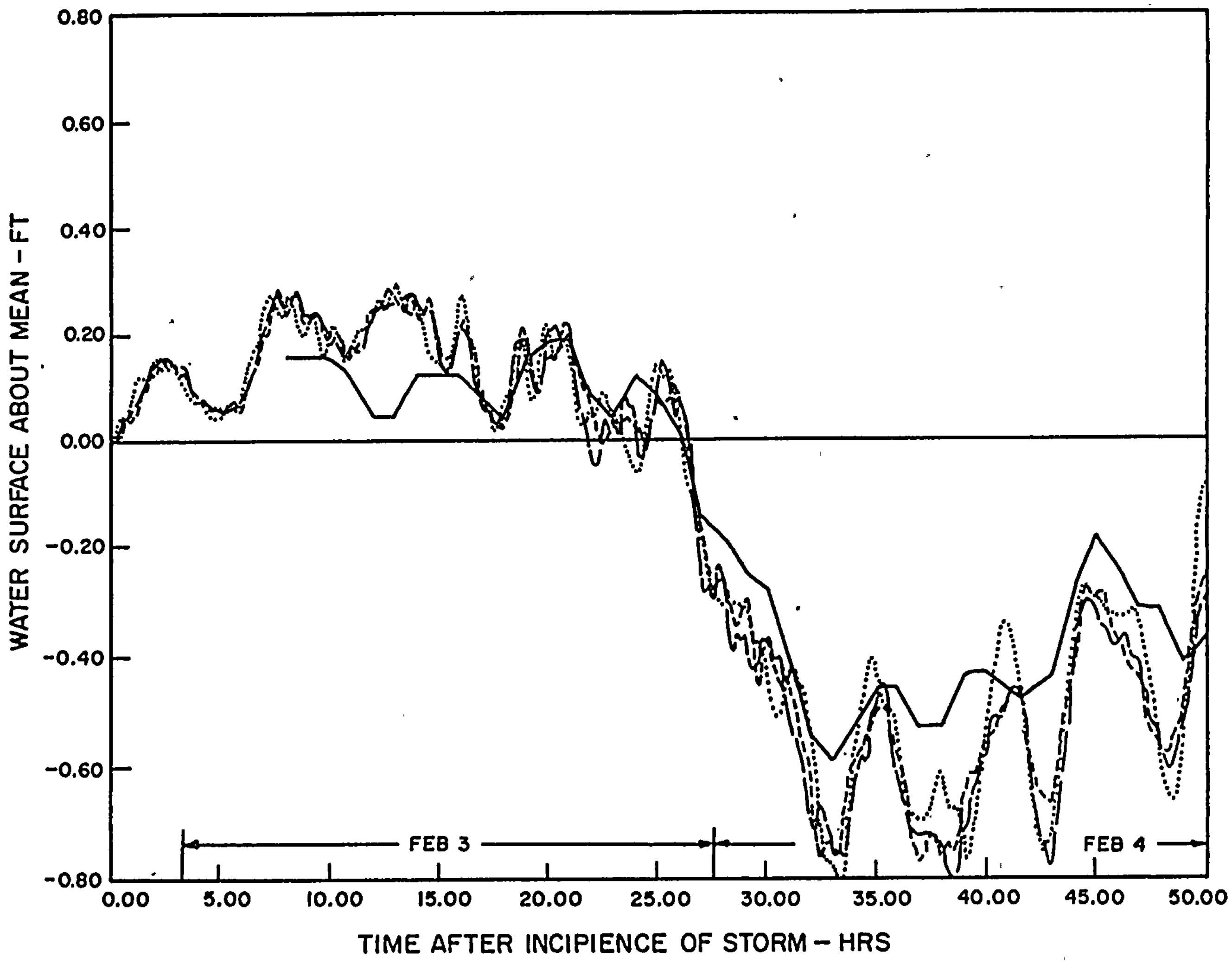


FIGURE 3

VARIATION OF WATER SURFACE
AT OSWEGO
STORM OF FEBRUARY 3, 1972
LAKE ONTARIO

NINE MILE POINT NUCLEAR STATION – UNIT 2
NIAGARA MOHAWK POWER CORPORATION



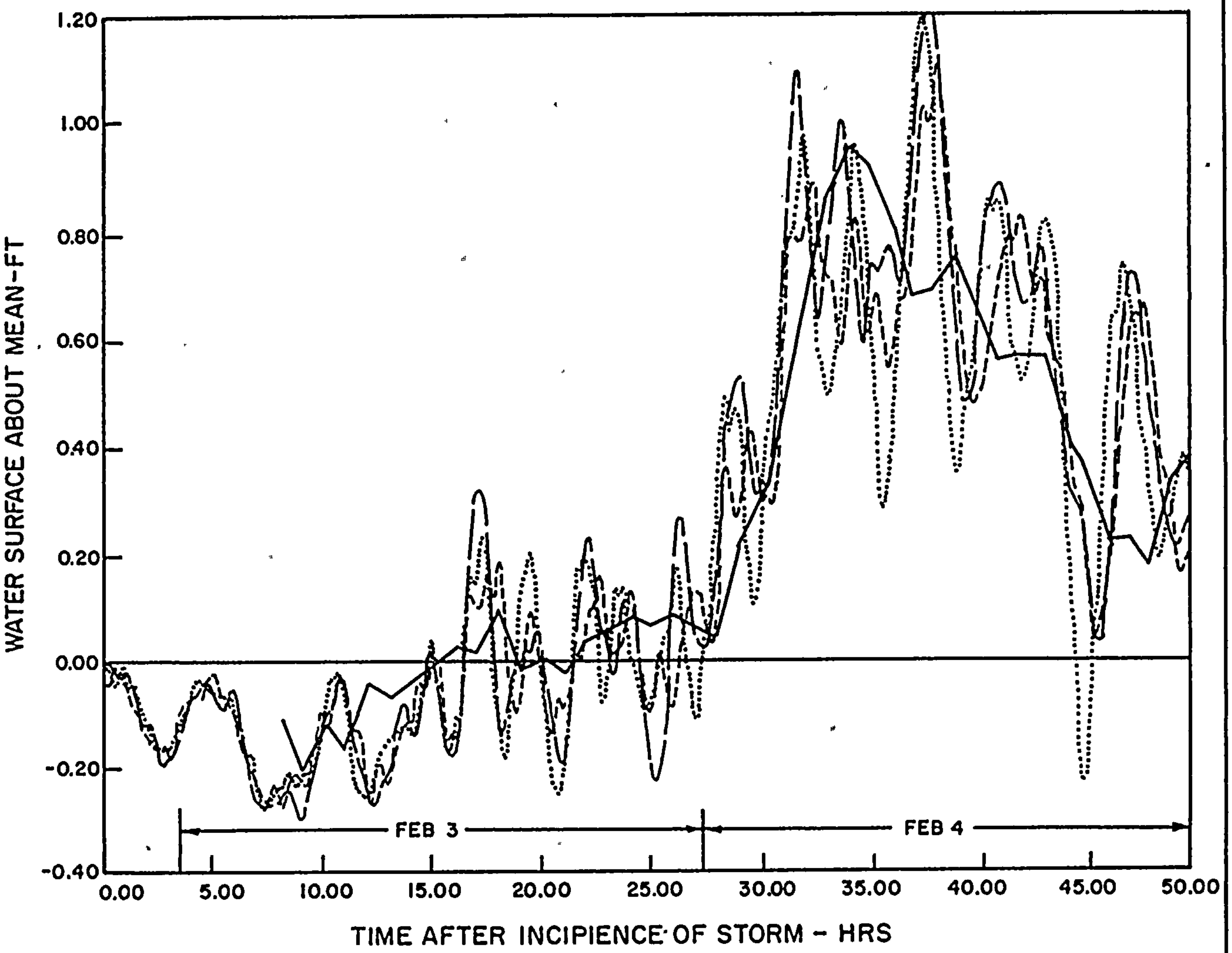
LEGEND

——	RECORDED DATA
	PREDICTED SURGE
- - - - -	GRID SIZE 20,000 FT
— —	GRID SIZE 30,000 FT
··········	GRID SIZE 15,000 FT

FIGURE 4

VARIATION OF WATER SURFACE
AT TORONTO
STORM OF FEBRUARY 3, 1972
LAKE ONTARIO

NINE MILE POINT NUCLEAR STATION – UNIT 2
NIAGARA MOHAWK POWER CORPORATION



LEGEND

———	RECORDED DATA
	PREDICTED SURGE
- - - - -	GRID SIZE 20,000 FT
— —	GRID SIZE 30,000 FT
…………	GRID SIZE 15,000 FT

FIGURE 5

VARIATION OF WATER SURFACE
AT CAPE VINCENT
STORM OF FEBRUARY 3, 1972
LAKE ONTARIO

NINE MILE POINT NUCLEAR STATION – UNIT 2
NIAGARA MOHAWK POWER CORPORATION