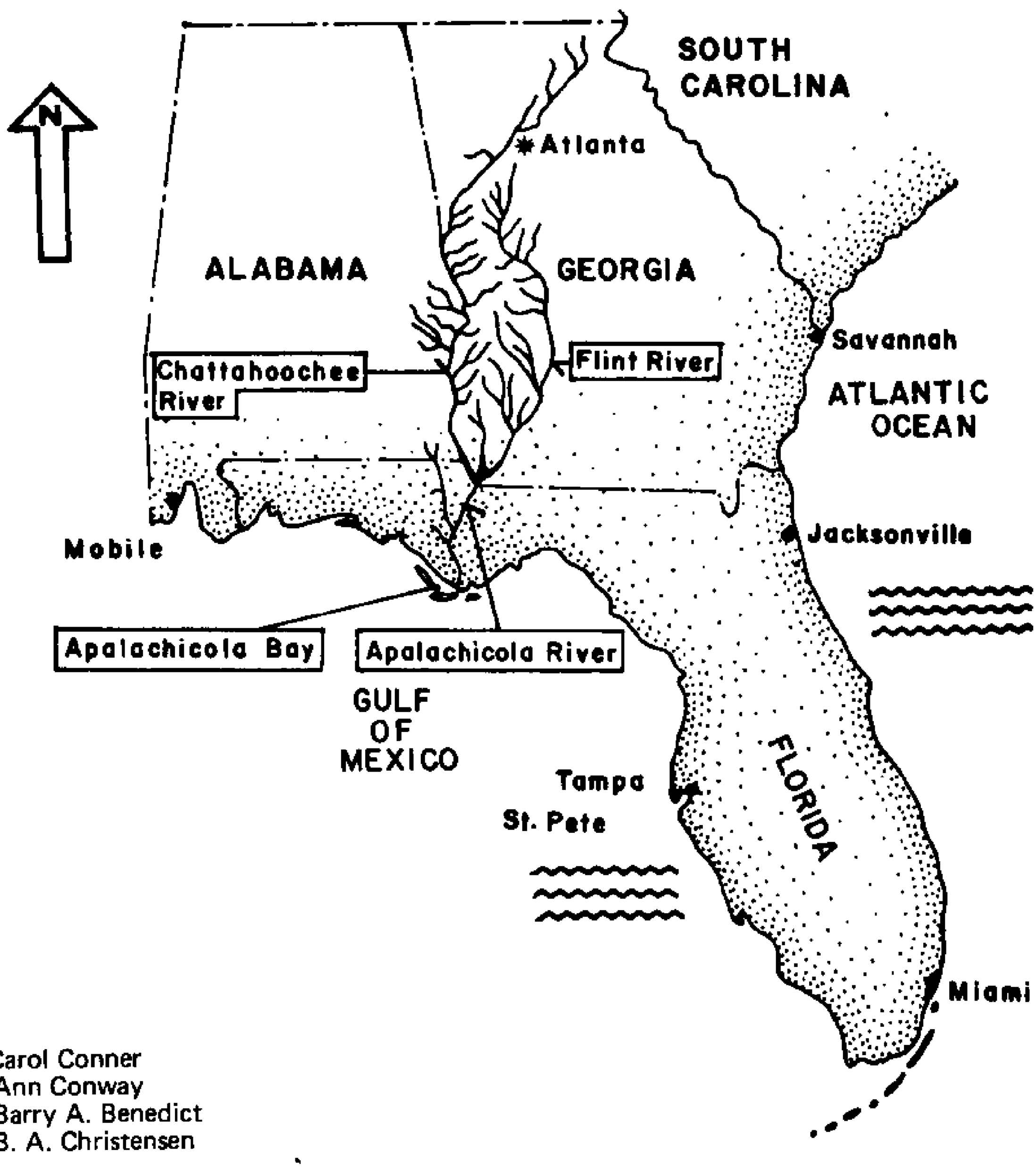
MODELING THE APALACHICOLA SYSTEM



By Carol Conner
Ann Conway
Barry A. Benedict
B. A. Christensen

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SEA GRANT

MODELING THE APALACHICOLA SYSTEM*

A Hydrodynamic and Water Quality Model
With a Hydrodynamic and Water
Quality Atlas of Apalachicola Bay
Project No. R/EM-13

By

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Hydraulic Laboratory
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1. INTRODUCTION

The present report discusses the establishment of a numerical model of the Apalachicola system consisting of the River, its tributaries and the biologically highly productive Apalachicola Bay. Much of the material has been published elsewhere in the form of reports (e.g., Graham, DeCosta, and Christensen, 1978), scientific papers (e.g., Christensen, 1979, Graham and Christensen, 1978) and bulletins of a more general nature (e.g., Hill and Graham, 1980).

The present report should therefore be considered as a review of the progress made with special emphasis on the final results that are presented in the form of an atlas depicting the hydrodynamics and pollutant migration in the Apalachicola Bay during an "average" year taking tidal flushing as well as wind and river flow into consideration. This atlas will allow the reader to determine water velocity, orientation of water velocity, water quality corresponding to any known water quality in the river, and salinity of the bay waters. The atlas is attached to the present report as Appendix A. The complete verified numerical model is attached as Appendix B on computer tape.

1.1 Logistics of Model Approach

Man's development of drainage basins draining to estuarine waters will always have an impact on the quality of these waters and therefore also on the biological system of the estuary in question. In the case of Apalachicola Bay this has clearly been demonstrated by Livingston (Livingston et al., 1981). A further impact on the economy depending on the estuarine biosystem and the ocean biosystem its supports must therefore be expected and should be considered by the responsible developer.

Such a consideration is certainly justified when it is recalled that our estuarine systems are among the most productive areas as far as biomass is concerned. Figure 1.1 shows a comparison of biomass production in ton per acre per year for typical areas. It should be noted that the estuarine production is two to four times that of our best agricultural land areas

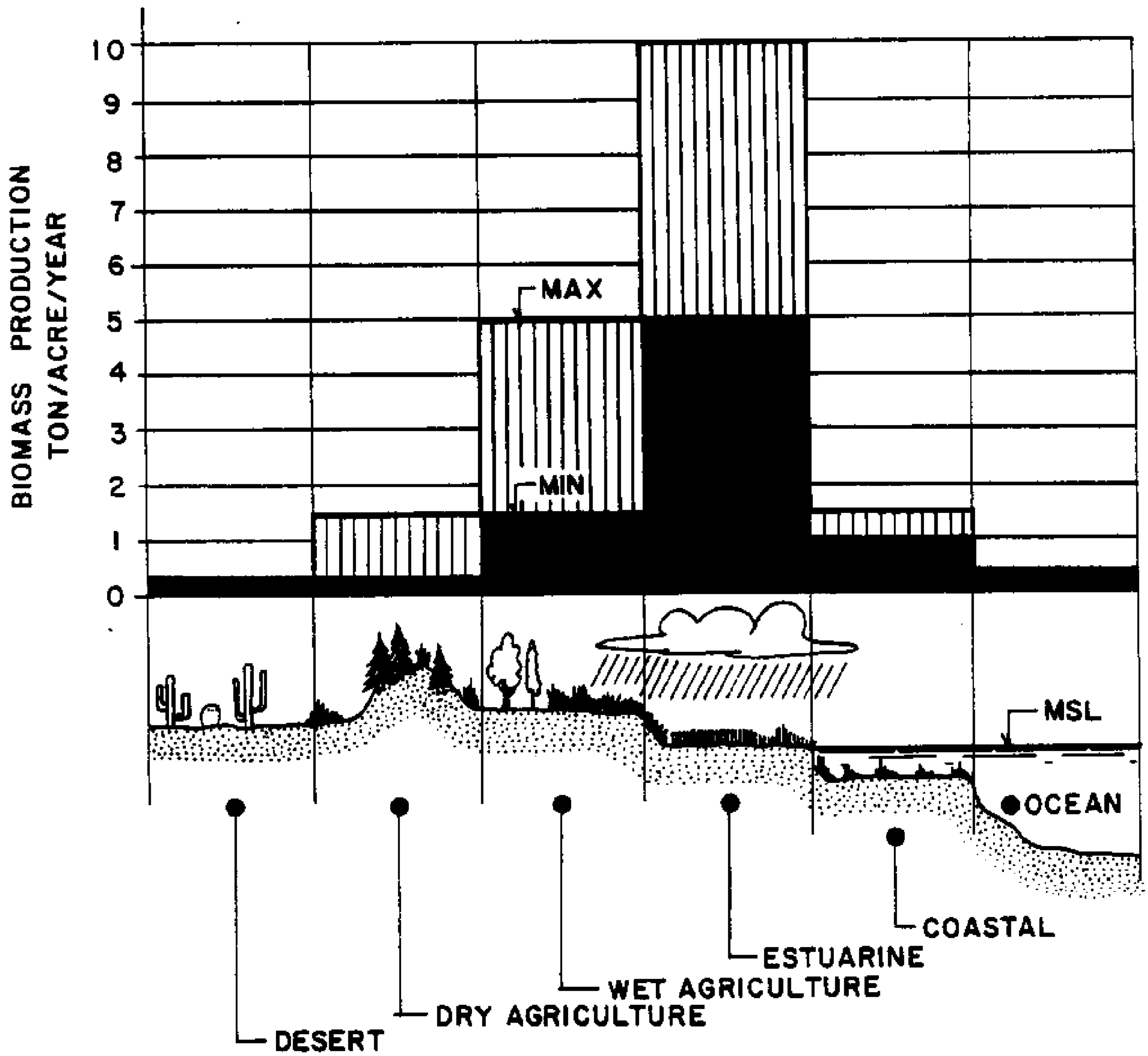


Figure 1.1. Comparison of Biomass Production Rates. (Source: Teal and Teal, 1969).

that, by the way, only can sustain their high production rates by extensive use of fossil fuel based fertilizers.

It is therefore recommended that the impact of development is evaluated and that the results of the evaluation is fed back to the developers or developing agencies to insure optimum utilization of our coastal resources.

Figure 1.2 is a flow chart showing the logistics of optimum land utilization by use of computer models. It is noted how the development's impact on the riverine system is evaluated by a predictive model and the output from this model serves as input to the estuarine model. The output from the estuarine model will again provide information enough in the form of water velocities, pollutant concentrations and salinities to enable the marine biologist to evaluate the impact on the estuary's biosystem. From these the economists may draw their conclusions as to the impact on the region's economical system which will serve as a foundation for further action in the political system providing the feedback to the planners and developers. A slighly more detailed flow chart is given in Figure 1.3.

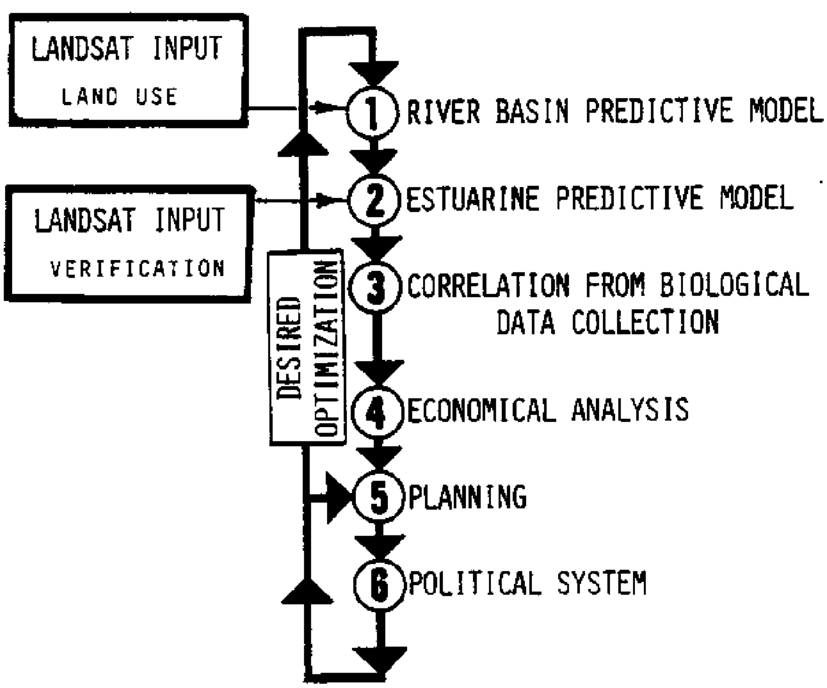


Figure 1.2. Logistics of Model Approach.

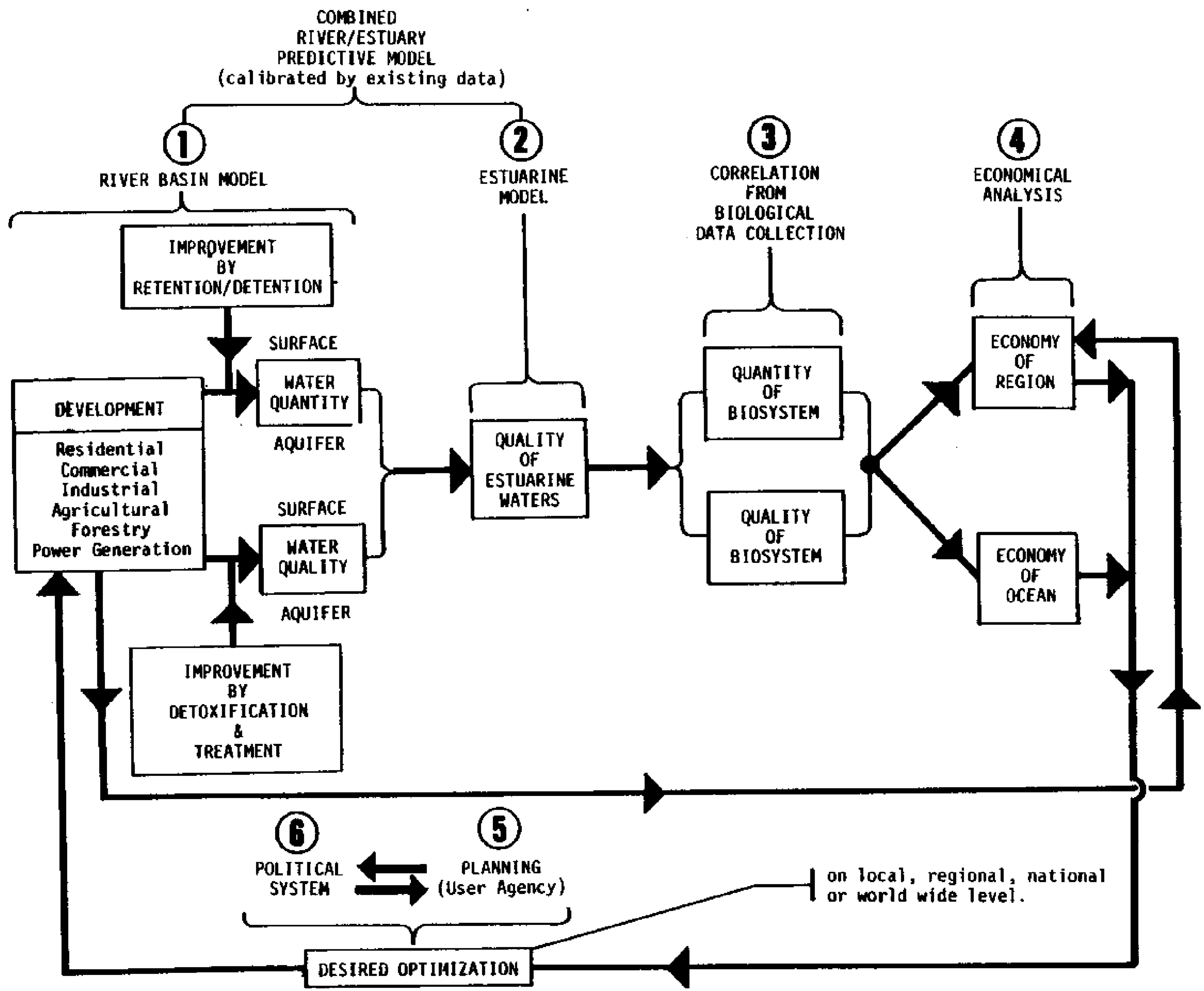


Figure 1.3. Detailed Flow Chart of the Model Approach to Rational Utilization of Coastal Drainage Basins.

The utilization of computer models in this scheme is of course quite obvious since physical models or full scale experimentation would be economically unrealistic if not completely impossible.

Since this work deals with large areas of land and sea, it is logical to utilize satellite imagery as input to the models and for verification of the results obtained by the models. This is indicated in Figure 1.2. Input from the LANDSAT system is suggested in the river model. For instance the LANDSAT images will give information about the present utilization of the land by colors as shown in the example of Figure 1.4 indicating how the drainage basin is used for silviculture in the neighborhood of Apalachicola Bay.

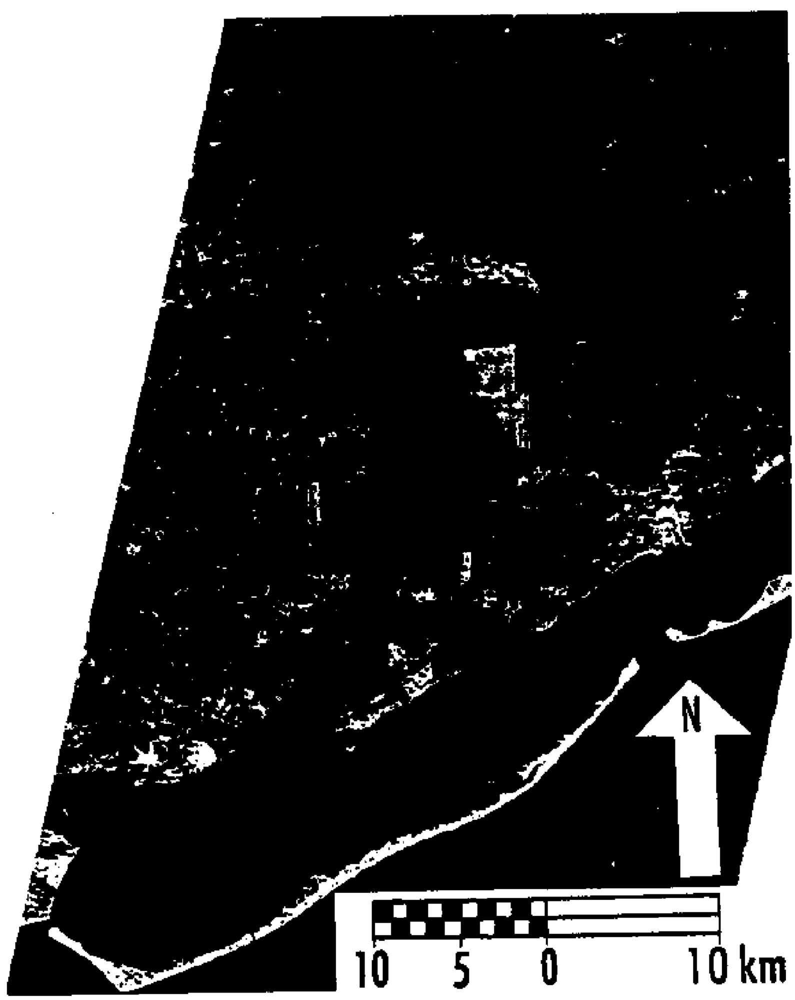


Figure 1.4. Computer Enhanced LANDSAT Image of Area North of Apalachicola Bay Showing Silvicultural Activities. August 19, 1976.

In Figure 1.4 white indicates sand or urban development while the color green shows marsh, swamp or natural forest. Purple areas are clearcut forest that has been harvested within one year of the date of the image. Orange is showing revegetated forest areas.

LANDSAT images enhanced for color (quality) of surface waters are used for verification by pattern recognition of water quality as discussed later in this report and by Graham, Hill and Christensen (1978).

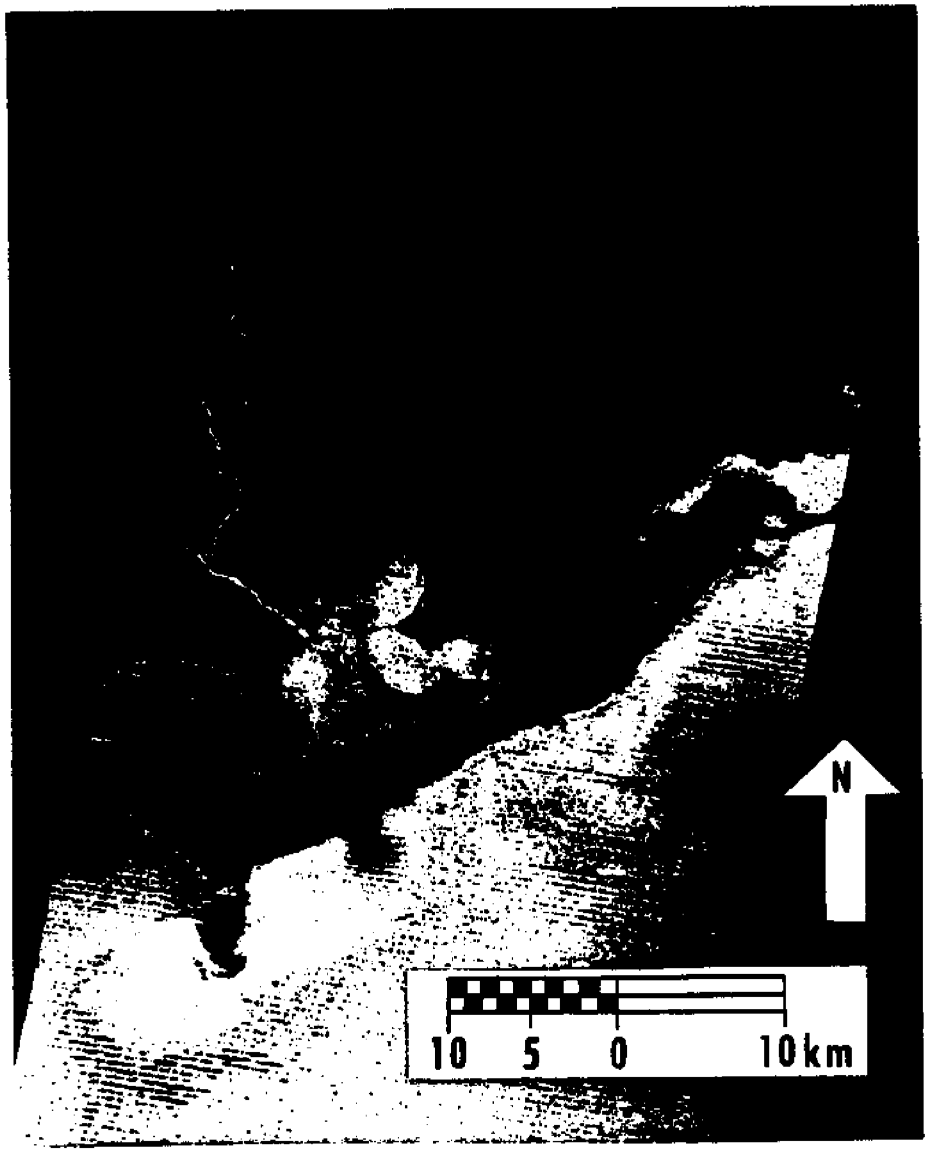


Figure 1.5. LANDSAT Image of Apalachicola Bay Computer Enhanced for Water Quality. Outgoing Tide.

Verification data are of course also obtained by direct observation of velocities and salinities in the bay.

1.2 The Apalachicola Basin/Estuary System

The Apalachicola Basin and Estuary system was selected for the modeling effort described in this report because of its relative simplicity as far as pollution and pollution sources go. Pollution of the river and bay waters is at the present time generally limited to a lowering of the pH probably caused by clearcutting of areas around East Bay. This phenomenon has been extensively studied and recorded by Livingston (Livingston, 1981) during the last decade. Information relating the increased acidity of the waters to the silvicultural activities is scarce and has not been available to the writers.

Although the model developed and verified in this report is specifically dealing with the Apalachicola system it should be emphasized that the general methodology applied may be used in other river-bay systems.

As shown in Figure 1.6 the water entering the Apalachicola Bay may originate as far away as from the Atlanta, Georgia, region from where it enters the Apalachicola River primarily through the Chattahoochee and Flint rivers. Briefly, the basin is about 50,500 km^2 in area and the Apalachicola River proper is considered to begin at the Florida line and flows about 170 km to the Gulf of Mexico. The river has been improved by the U.S. Army Corps of Engineers to Bainbridge, Georgia, and a large reservoir has been established at the Florida line.

The Apalachicola River has very good hydrologic data. The mean yearly hydrograph for the decade 1967 through 1976 is shown in Figure 1.7. The yearly average discharge is about 700 m^3s^{-1}. This is a substantial

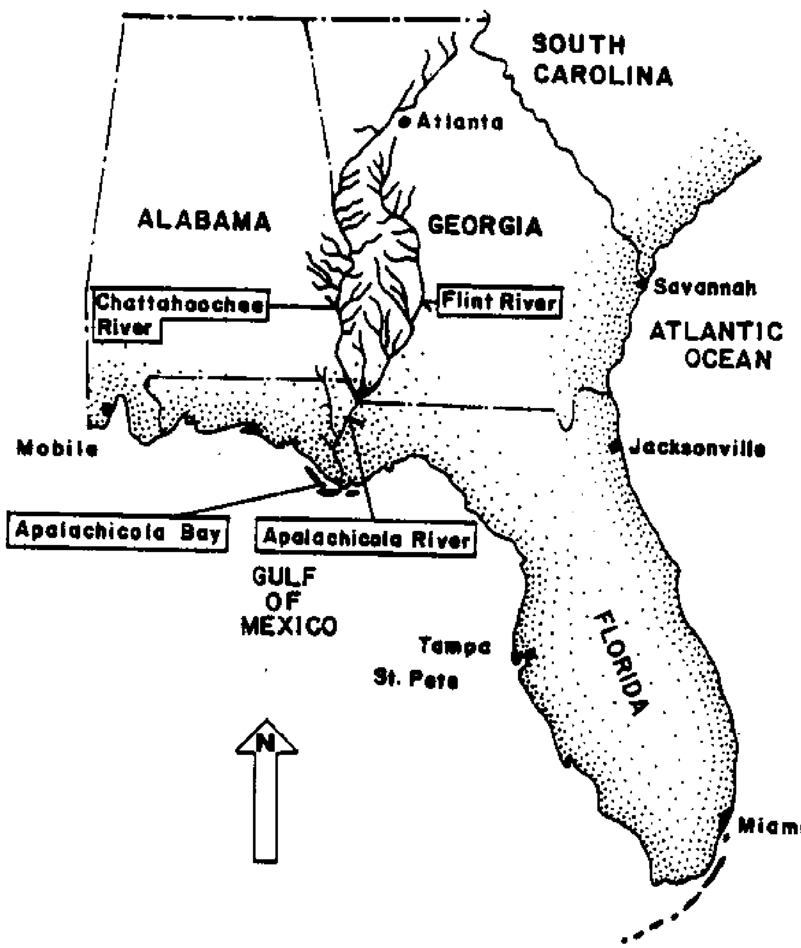


Figure 1.6. The Apalachicola River/Bay System with Tributaries.

discharge. However, compared to the rate of tidal exchange of waters in the bay it is very small. The river is therefore having only a limited influence on the hydrodynamics of the Apalachicola Bay.

Apalachicola Bay, shown in Figure 1.8, is a barrier island-contained estuary on the Florida Panhandle. It is geomorphically typical of such systems, but is significant because of the importance of its waters to marine life (Livingston, 1981). At present, it suffers relatively low levels of point-source pollution.

The bay is about 550 Km^2 in area, depending upon where the boundaries are drawn. Mean depth is about 2 meters and is everywhere less than 3 meters except in West Pass. As expected the system is dominated by the

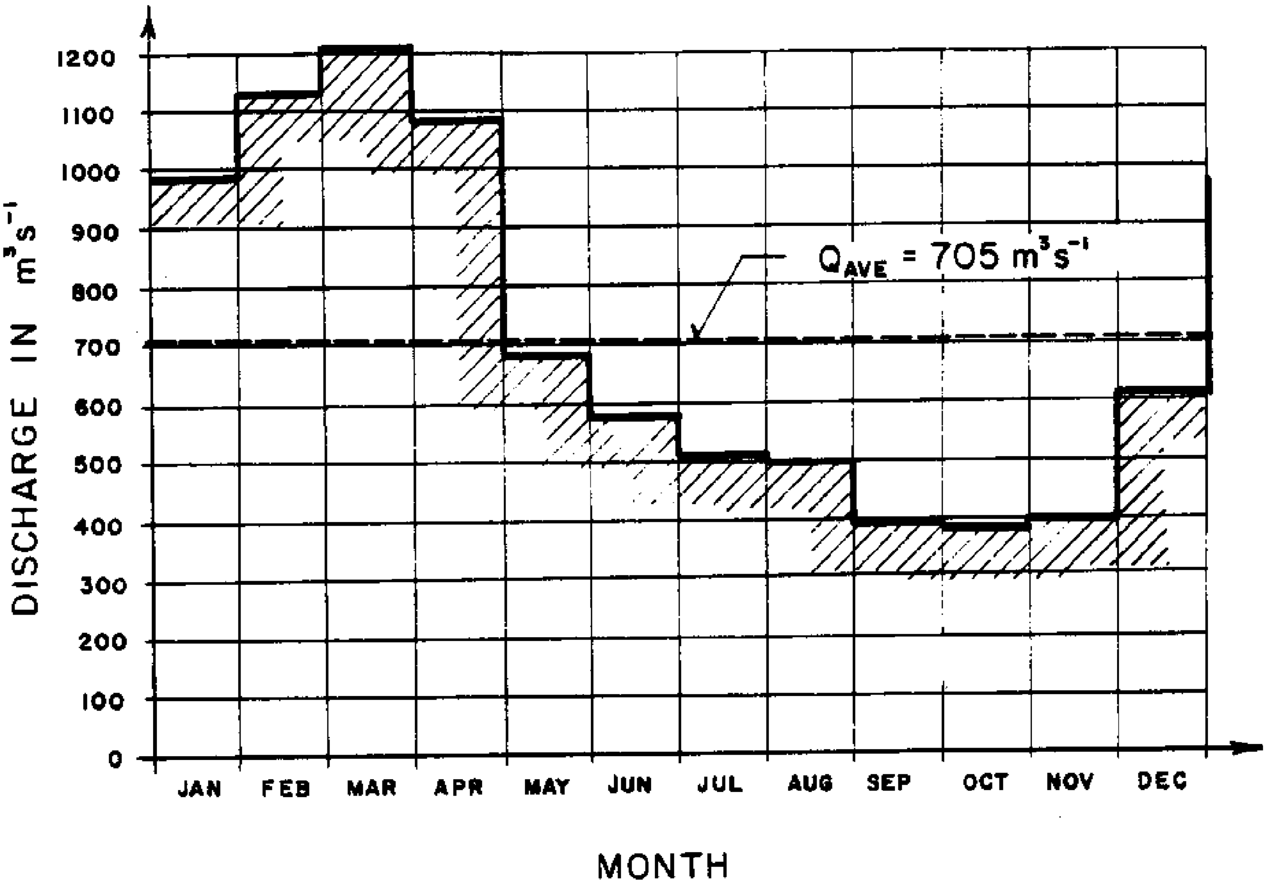


Figure 1.7. Mean Yearly Hydrograph for Apalachicola River for 1961 - 1976.

Apalachicola River whose mean annual discharge is about 700 m^3/s. The mean tidal range at Apalachicola is 0.40 m. The tidal prism is thus 220 million m^3 on the average and the mean residence time per river water about 17 days.

In general the bay is shallow, well-mixed and prone to being wind-driven. Little else is known about its hydrography. It is quite remarkable that the entire literature on the hydrography of one of the largest estuaries on the Gulf Coast can be easily read in about fifteen minutes. Most of the hydrographic data has been collected by biologists and is not readily useful for engineering or oceanographic purposes, nor has it been interpreted in a physically rigorous manner. Figure 1.8 shows the major points of hydraulic interest in the modeling effort. These are, beginning at the east side and proceeding in a clockwise manner, East Pass between St. George Island and Dog Island, Sikes Cut penetrating St. George Island, West Pass between Sand Island and St. Vincent Island, Indian Pass between St. Vincent Island and the Florida Panhandle, the Apalachicola River entering the bay north of the city of Apalachicola, and East Bay receiving much of the runoff from the land areas used for silviculture in Franklin County.

The following Figures 1.9 through 1.21 are aerial photos of these points taken from the flight path in Figure 1.8 at the locations marked A through M.

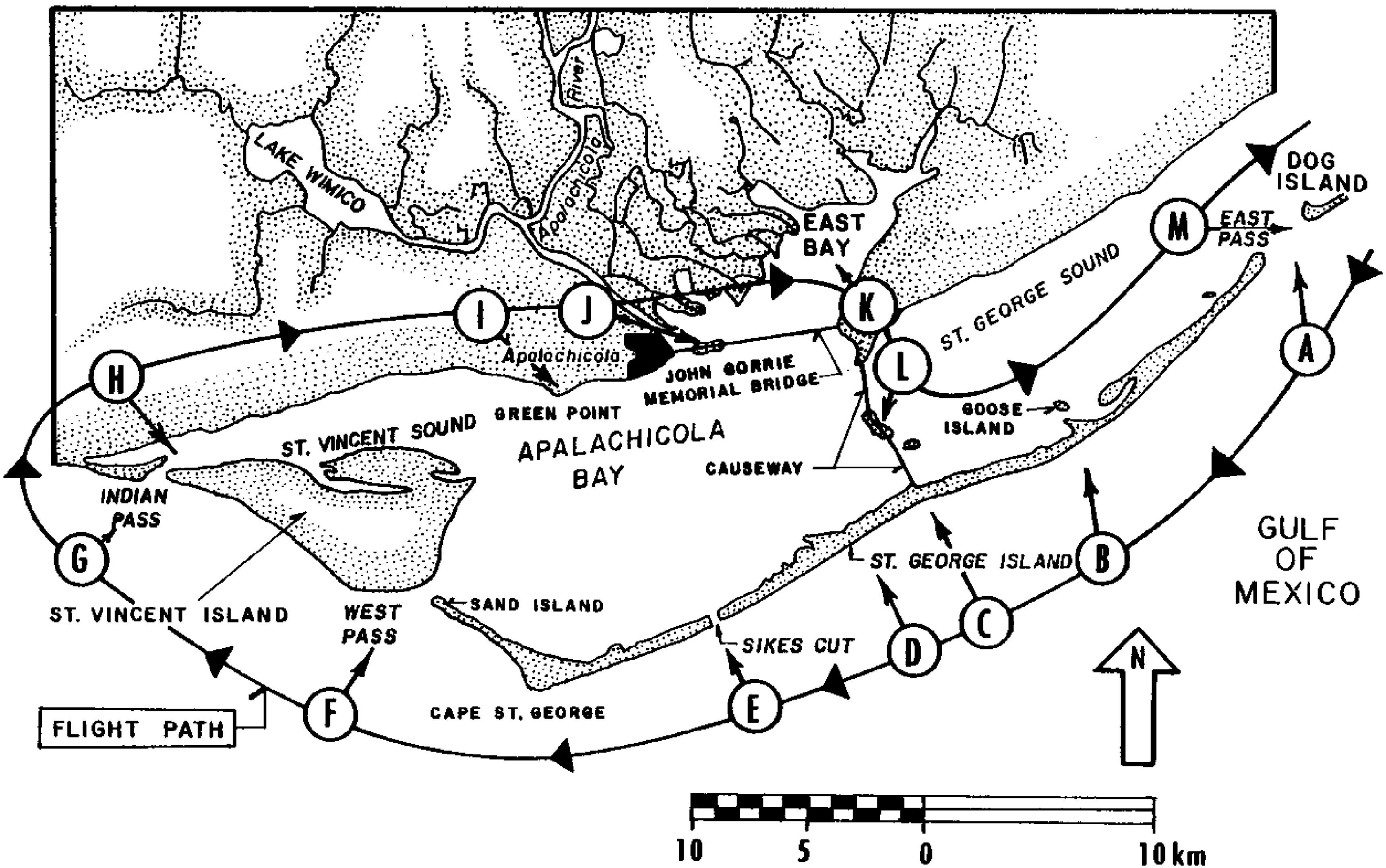


Figure 1.8. The Apalachicola Bay. Flight Path Used When Figures 1.9 Through 1.21 Were Taken

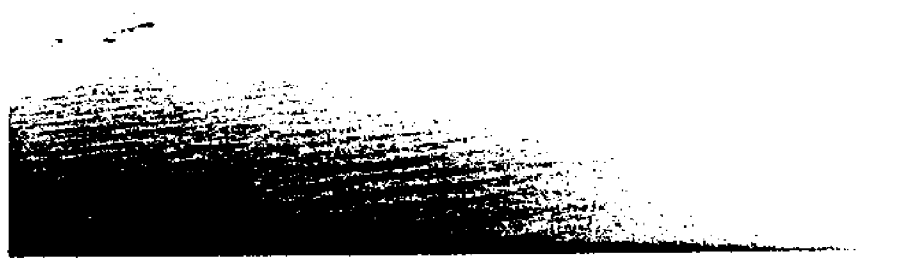


Figure 1.9. Apalachicola Bay. VIEW A: East Pass Seen from South. Left: St. George Island. Right: Dog Island.

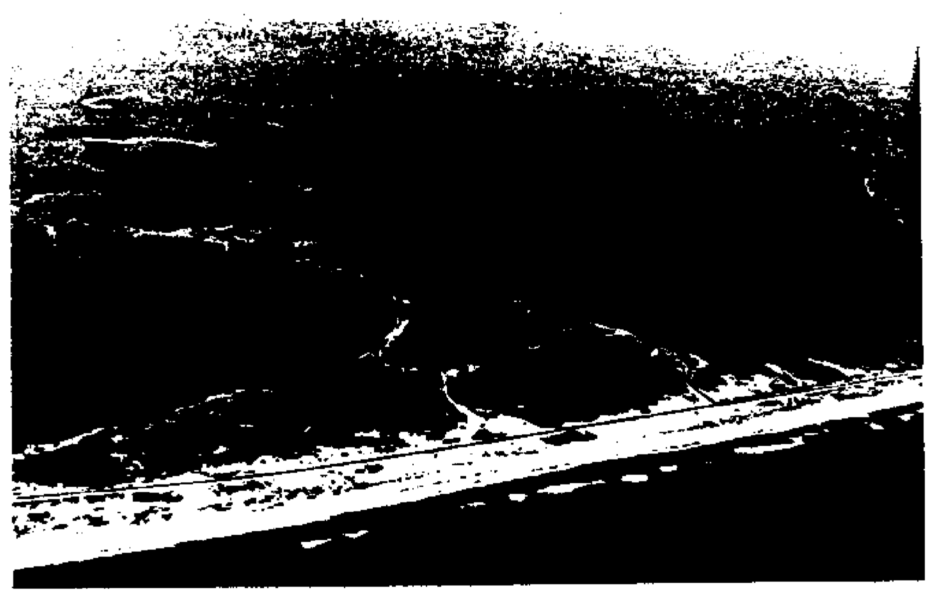


Figure 1.10. Apalachicola Bay. VIEW B: St. George Island at Rattlesnake Cove and Goose Island Seen from South.

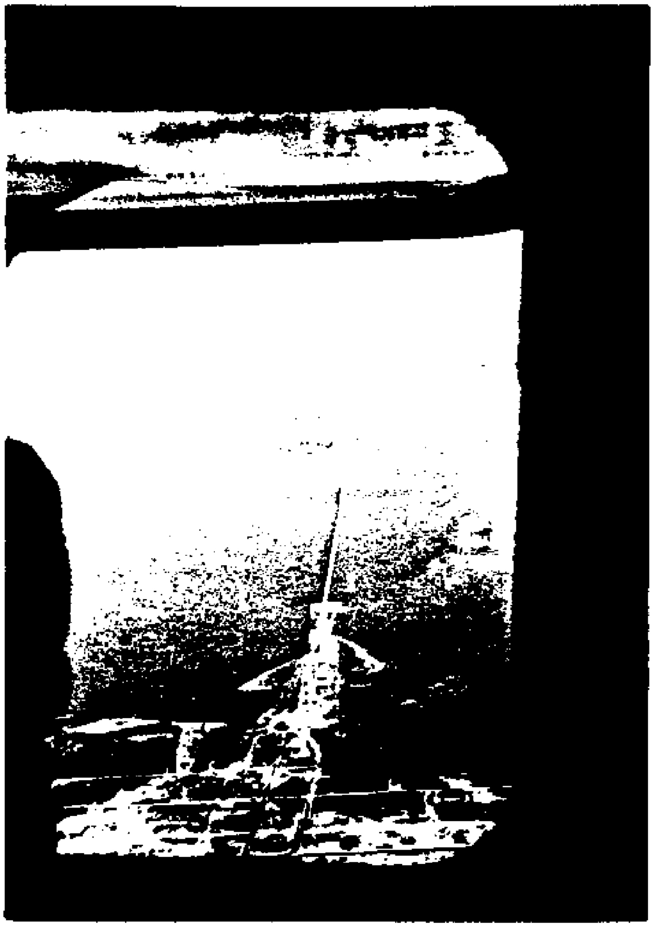


Figure 1.11. Apalachicola Bay. VIEW C. St. George Island at Causeway Seen from South.

Figure 1.12. Apalachicola Bay. VIEW D. St. George Island between Causeway and Sikes Cut Seen from South.

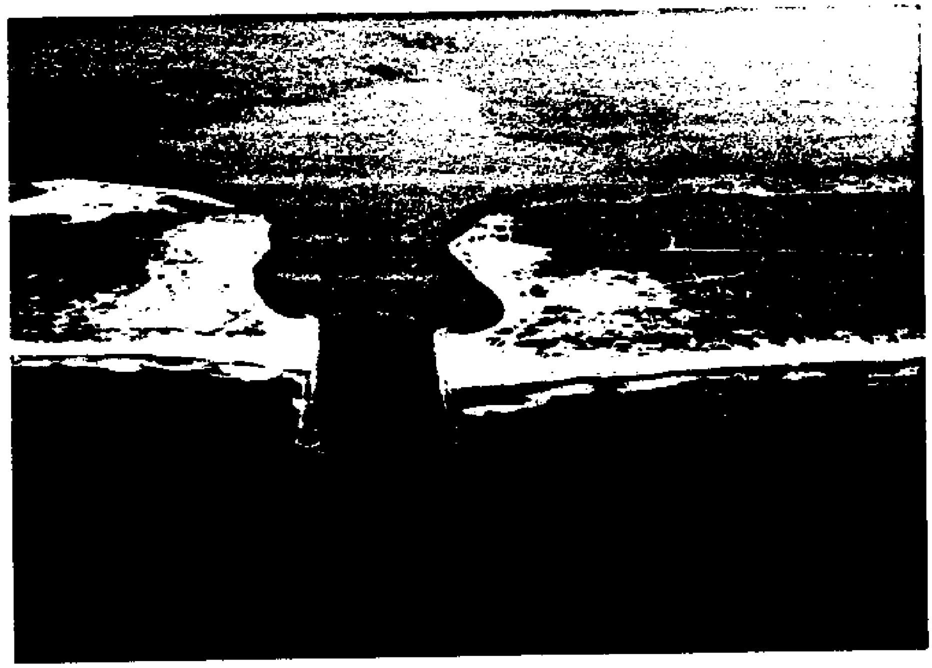


Figure 1.13. Apalachicola Bay. VIEW E. Sikes Cut Seen from the Mexican Gulf.

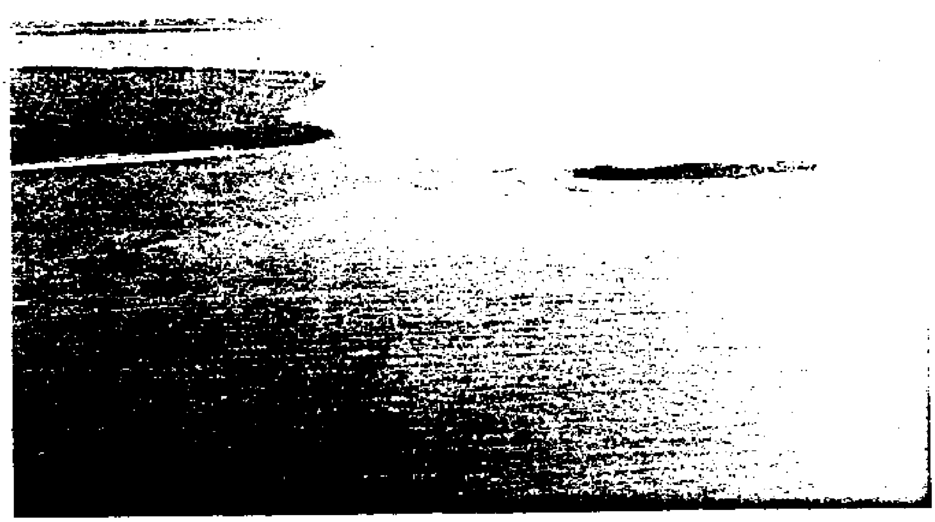


Figure 1.14. Apalachicola Bay. VIEW F. West Pass Seen from Southwest. Left: St. Vincent Island. Right: St. George Island (Sand Island).

Figure 1.15. Apalachicola Bay. VIEW G. Indian Pass Seen from Southwest. Right: St. Vincent Island.

Figure 1.16. Apalachicola Bay. VIEW H. Indian Pass Seen from Southwest. Left: St. Vincent Island.

Figure 1.17. Apalachicola Bay. VIEW I. North Shore of Bay at Green Point Seen from Northwest.

Figure 1.18. Apalachicola Bay. VIEW J. The Apalachicola River Entering Bay at City of Apalachicola (Right) Seen from Northwest. John Gorrie Memorial Bridge.

Figure 1.19. Apalachicola Bay. VIEW K. East Bay Seen from Southeast.

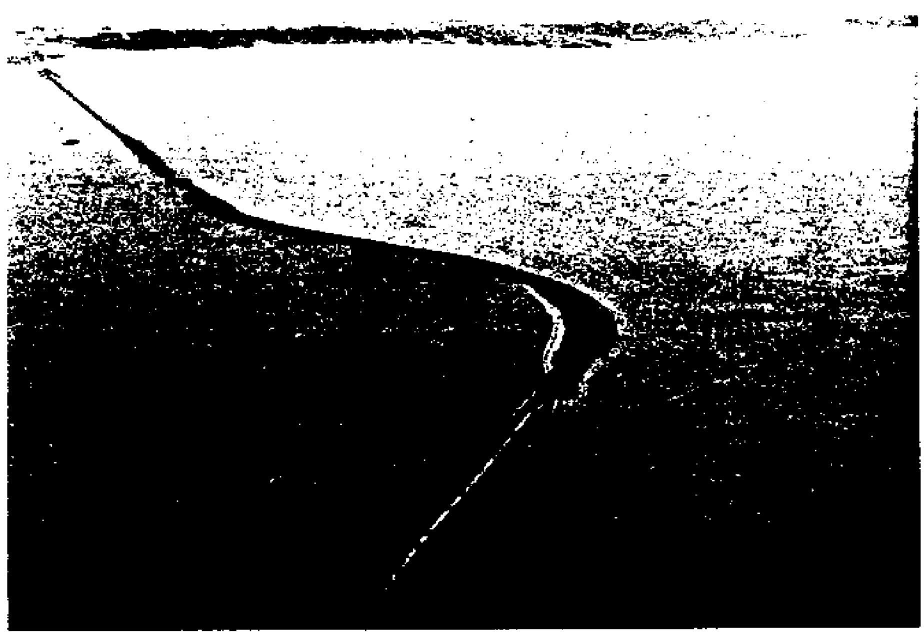


Figure 1.20. Apalachicola Bay. VIEW L. St. George Island Causeway Seen from North.

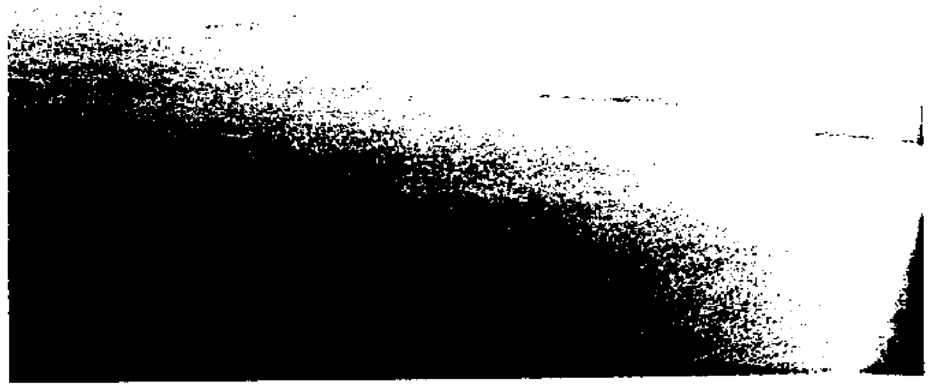


Figure 1.21. Apalachicola Bay. VIEW M. East Pass Seen from West. Left: Dog Island. Right: St. George Island.

1.3 Classification of Apalachicola Bay

Estuaries are often classifed according to the degree and manner in which they are stratified. Stratification is a function of river flow, tidal prism, volume, depth-wide ratio, density difference, hydraulic roughness and so forth. Classification schemes have been proposed (Pritchard, 1970, 1973) which are based on several dimensionless parameters:

$$\frac{P}{TQ}, \frac{\rho_2 - \rho_1}{2}, \frac{D}{L}, \frac{R}{D} \qquad (1.1)$$

where

T = tidal period (12.42 hr)

P = tidal prism

Q = river discharge

ρ_1, ρ_2 = characteristic extreme densities

L = estuary length

D = average estuary depth

R = tidal range

If ρ_1 corresponds to s (salinity) = 0 and ρ_2 to s = 32% (ocean value) and R is (almost) constant, then any classification scheme must be a function of at least 2 parameters - one expressing inertial mixing ability and the other reflecting geometry. For a given estuary, geometry and hydraulic characteristics are fixed so a classification scheme is primarily based on

$$\frac{P}{TQ} \tag{1.2}$$

and, since T is also fixed, it can be seen to be a simple function of retention time providing the estuary depth is not greatly dependent upon river discharge.

The foregoing analysis has not considered wind shear, which is a very important mixing mechanism for small D/L.

Considering the above and Pritchard's estuarine classification scheme shown in Figure 1.22 the Apalachicola Bay may be characterized as a width dominant estuary controlled by tidal currents originating from astronomical as well as wind tides. It is a type D estuary.

1.4 The Apalachicola Bay Numerical Model and Atlas of Hydrodynamics and Water Quality

Since the Apalachicola Bay is only slightly influenced by the river discharge as far as the bay's hydrodynamics goes it was decided to use the mean yearly hydrograph for Apalachicola River shown in Figure 1.7 as river model input to the hydrodynamic estuarine model.

Water velocities, their orientation and water surface elevations are modeled by use of the Wang-Connor CAFE-1 model (Wang and Connor, 1975). This is a vertically integrated finite element model.

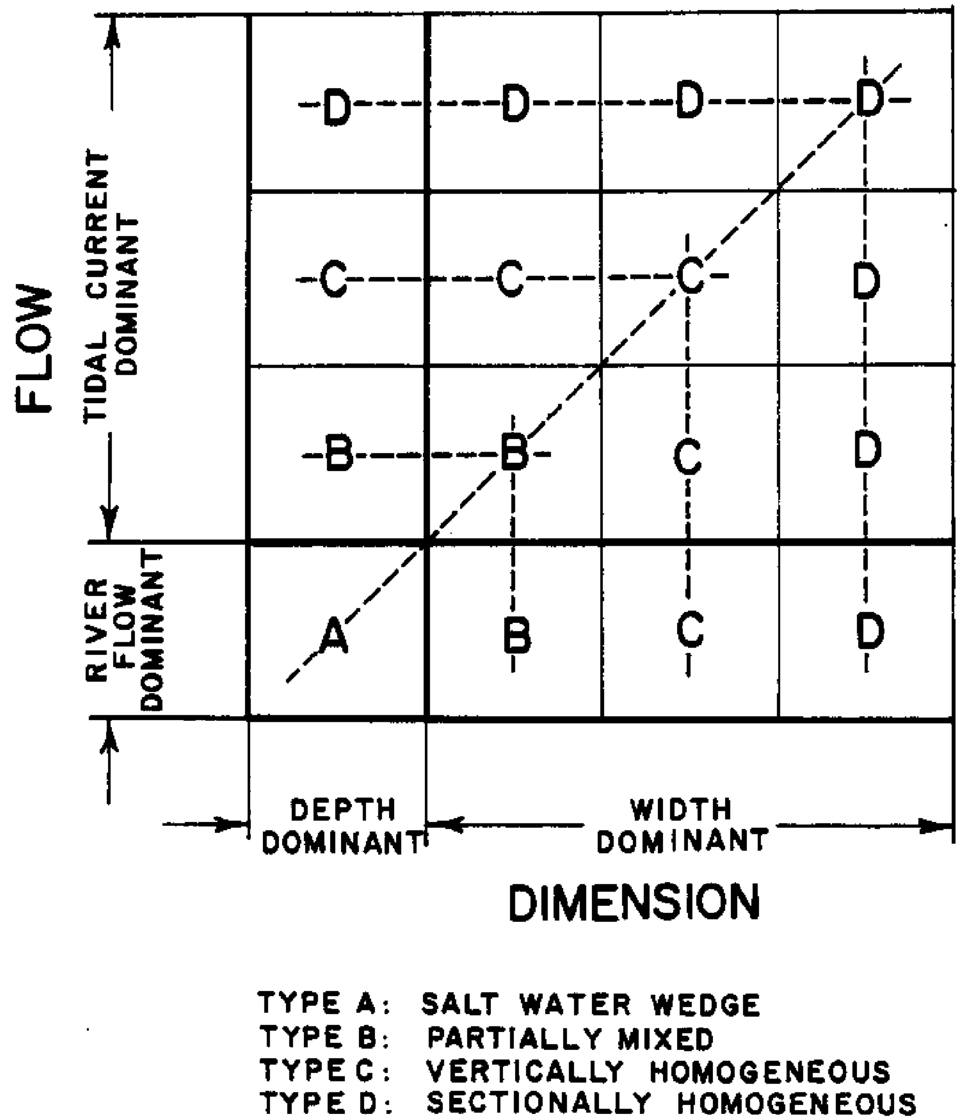


Figure 1.22. Pritchard's Estuarine Classification Scheme. Pritchard (1970, 1973).

Water quality is modeled by use of the Wang-Connor DISPER-1 model (Wang and Connor, 1975) and the output from the CAFE-1 model. DISPER-1 is also a finite element model.

Since very little is known about the present and future water quality of the river an arbitrary pollution concentration of 100 units have been used in the quality model. This, together with a fairly simple formula for conversion of the computer printout will allow the user of the reported results to compute the water quality at any location and time in the bay corresponding to any pollutant concentration in the river. At the present time the quality model is limited to conservative pollutants. However, later introduction of decay and generation terms in the governing equation will allow extention to nonconservative substances.

The final results are given for the 12 months of the typical year during which average tides, winds and river flow are presumed to prevail. The conditions are given for the typical tidal cycle for each month. Velocity, net velocity as well as water quality corresponding to river concentration 100 are given. Conditions are given for time increments equal to one-eighth of a tidal cycle beginning at low tide. Thus each month will be represented by 8 velocity maps, 1 net velocity map, and 8 water quality maps. The total of these 204 maps makes up the atlas given at the end of this report.

2. SELECTION OF MODELS

A short discussion of the selection of the model is given in this chapter. For a more complete discussion the reader is referred to an earlier report to Sea Grant (Graham, DeCosta and Christensen, 1978).

2.1 Criteria for Selection

The primary criterion for selection of any model must of course be their ability to accurately reflect existing and projected behavior in the water body of interest. The basic characteristics of behavior of Apalachicola Bay are described briefly in Section 1 of this report and in more detail by Graham, DeCosta and Christensen (1978). It was concluded that a two-dimensional vertically, averaged numerical model was appropriate for Apalachicola Bay due to its generally well-mixed body of water. It is likely that Apalachicola Bay would represent the case in Florida where this assumption is most marginal, so that application to most other Florida estuaries would be justified.

It was felt that a real-time hydrodynamic capability was required to properly simulate transient velocities and quality in the bay, since tidal flow dominates and stormwater inflow is transient by definition. Since many of the concentration terms (of the form $\overline{u'c'}$) in the equations are nonlinear, it is not justified to use tidally-average net-flow models.

A primary goal was to reduce the sub-grid scale eddy diffusivity so that the quality model will be as predictive as possible.

While the real-time 2-D hydrodynamic and dispersion models are definitely state-of-the-art, 3-D and multi-layer models are not (in the author's opinion). While promising results are being made with 2-layer and multi-layer models, they must still be considered to be in a development phase at least in terms of the capabilities of most potential users in Florida. Data requirements for loading a multilayer model are formidable, so the likelihood of reliable applications is even further removed.

To summarize, the selection criteria used were:

1) model must be a least two-dimensional
2) model must simulate transient conditions
3) model must be sophisticated, yet readily available, proven, and tested
4) model must be nonproprietary, or documented to the extent that it is effectively nonproprietary
5) model must be "state-of-the-art", but past the research phase
6) model must be able to be run by users with reasonable proficiency
7) model must be able to be run at a reasonable cost
8) model must be flexible, not site-specific, in its applicability
9) model must be compatible with a water quality package
10) model must be able to simulate conditions typical of the Apalachicola, and most other Florida estuaries, viz.:
    a) shallow
    b) influenced by freshwater inflow, tides and wind.

2.2 Models Considered

Earlier reports and papers describe the several models considered for application to Apalachicola Bay according to the criteria in Section 2.1. The strategy was to select a model for the hydrodynamics first.

After this model was chosen, a compatible water quality model could be selected.

Among models considered were the following, with more detail given by Graham (1977), Graham, DeCosta and Christensen (1978), and Graham, Daniels and Christensen (1979).

1. Hydroscience Estuary Model (Hydroscience, 1977).
2. Dynamic Estuary Model (also forms the receiving water model, RECEIV, for the EPA Storm Water Management Model (SWMM) - (Feigner and Harris, 1970)). See also Huber et al. (1975).
3. Leendertse Finite-Difference Model (Leendertse, 1967).
4. Masch Gulf Coast Model (Masch et al., 1969).
5. M.I.T. Finite Element Models

   CAFE-1 for hydrodynamics (Wang and Connor (1975), Pagenkopf et al. (1976))

   DISPER-1 for water quality (Leimkuhler, et al. (1975), and Pagenkopf et al. (1976))

A number of other models were considered and discarded at an early stage, especially those with no real time tidal characteristics (which is also true of model 1 above). Extensive reviews are provided elsewhere and will not be repeated here.

2.3 Models Selected

Based on a review of available models, coupled with the criteria presented in Section 2.1, it was decided that one package, the CAFE-1, DISPER-1 system developed at M.I.T. (also for Sea Grant) seemed overwhelmingly superior. In addition to technical and verification advantages, it was deemed important to select this finite element model for several reasons:

1) it provides more flexibility in discretizing the spatial net,

2) nodes can be placed at known measurement stations,

3) finite element models were recommended by Dr. Frank Masch, formerly of WRE, and Dr. John Wang of the University of Miami, both recognized experts in the field,

4) Wang and Connor's (1975) finite element model has recently been applied by Swakon and Wang (1977) to Biscayne Bay with good results,

and 5) tapes and advice are available from Dr. Wang at the University of Miami.

3. SPECIFIC FEATURES OF MODELS USED

In the following, only sufficient model detail will be presented to enable understanding model features and limitations. More detail can be found in the basic references and in earlier Sea Grant reports on this work. (See, for example, Graham, Daniels and Christensen, 1979).

3.1 The CAFE-1 Model

3.1.1 General Description

The CAFE-1 (standing for 1-layer Circulation Analysis by Finite Elements) model was developed and tested by M.I.T. (Wang and Conner, 1975). It has the following general properties:

1) Real time, i.e., describing velocities and depths through the tidal cycle.
2) Finite-element formulation.
3) Implicit time stepping.
4) One-layer, i.e., it is vertically integrated.

The model differs from other popular ones based on the Leendertse finite-difference format in that a finite element computation scheme is used. This computational scheme is more complicated, but has two very significant advantages:

1) The elements can be of different size.
2) The elements can assume almost any configuration, providing a triangular network is used.

Thus, the finite element grid can very closely approximate the geometrical boundaries of the body of water being modeled, while a finite difference scheme must approximate the boundary as the edges of squares.

Since the finite element grid sizes can be of arbitrary size (usually finite difference meshes are of one size), the grid can be made finer in narrow enclosed areas as well as in areas of interest. Conversely, the grid size can be made more coarse in large open areas, and in areas outside of the region of interest. The advantage of having finer resolution only in the region of interest is that computing costs, which are proportional to number of elements, are reduced. The advantage of closely approximating the boundary geometry in a hydrodynamic model is also quite important for obvious reasons. Since pressure terms dominate, and these are easy to measure and/or obtain from published data, for instance from tide tables, and since the results are not greatly sensitive to reasonable value choices of bottom roughness (Manning's n) and internal stress coefficients it follows that a very good approximation to the circulation can be computed with very little (and inexpensively acquired) input data. Since verification and calibration of numerical models can be quite expensive, one which is intrinsically quite accurate can reduce total modeling costs substantially by minimizing the empirical modification requirements.

During the study period, several grids were utilized to model Apalachicola Bay. Each was generally characterized by finer grid (higher resolution) in the East and West Bayou areas and in the East Bay region, with moderate refinement in the Sikes Cut area and coarser grid elsewhere. Other specialized grids could easily be developed to study other features in the bay, although experience has shown that each new grid has special problems in model stability and convergence to be overcome. These problems will be discussed in more detail later.

Inputs to CAFE-1 include

1) a grid, which requires nodes and elements to be defined

2) depths at each node

3) boundary orientations

4) wave amplitude, phase and/or flux at boundaries

5) latitude

6) wind speed and direction

7) Manning roughness } operator controlled

8) internal stress }

These are relatively easy to come by, at least for the United States. Outputs include

1) unit discharge vectors and/or velocities

2) heights above mean low water

for every node point for every timestep. In this case, the unit discharge values (q_x and q_y) and a height were output for each node for a tidal cycle of 744 minutes.

For preliminary purposes the water level was initially set to zero and the model run until a periodic steady state was achieved (by 3 tidal cycles). The output data for a steady tidal cycle were then written on a disk. The data on the disk could then be manipulated and/or called for graphical display, or used as input to the dispersion model DISPER-1. For sinusoidal tides, repeating over each cycle, and use of a single cycle called from memory to drive DISPER-1 result in considerable savings. The CAFE-1 program results presented later for the grid with 281 nodes and 439 elements, shown in Figure 3.1, typically took about 450 seconds CPU time at a cost of about $25.00 on the University's IBM 3033 System for simulation of four tidal cycles.

The CAFE-1 model, as mentioned, was originally developed at the R.M. Parsons Laboratory at M.I.T. It has been applied to

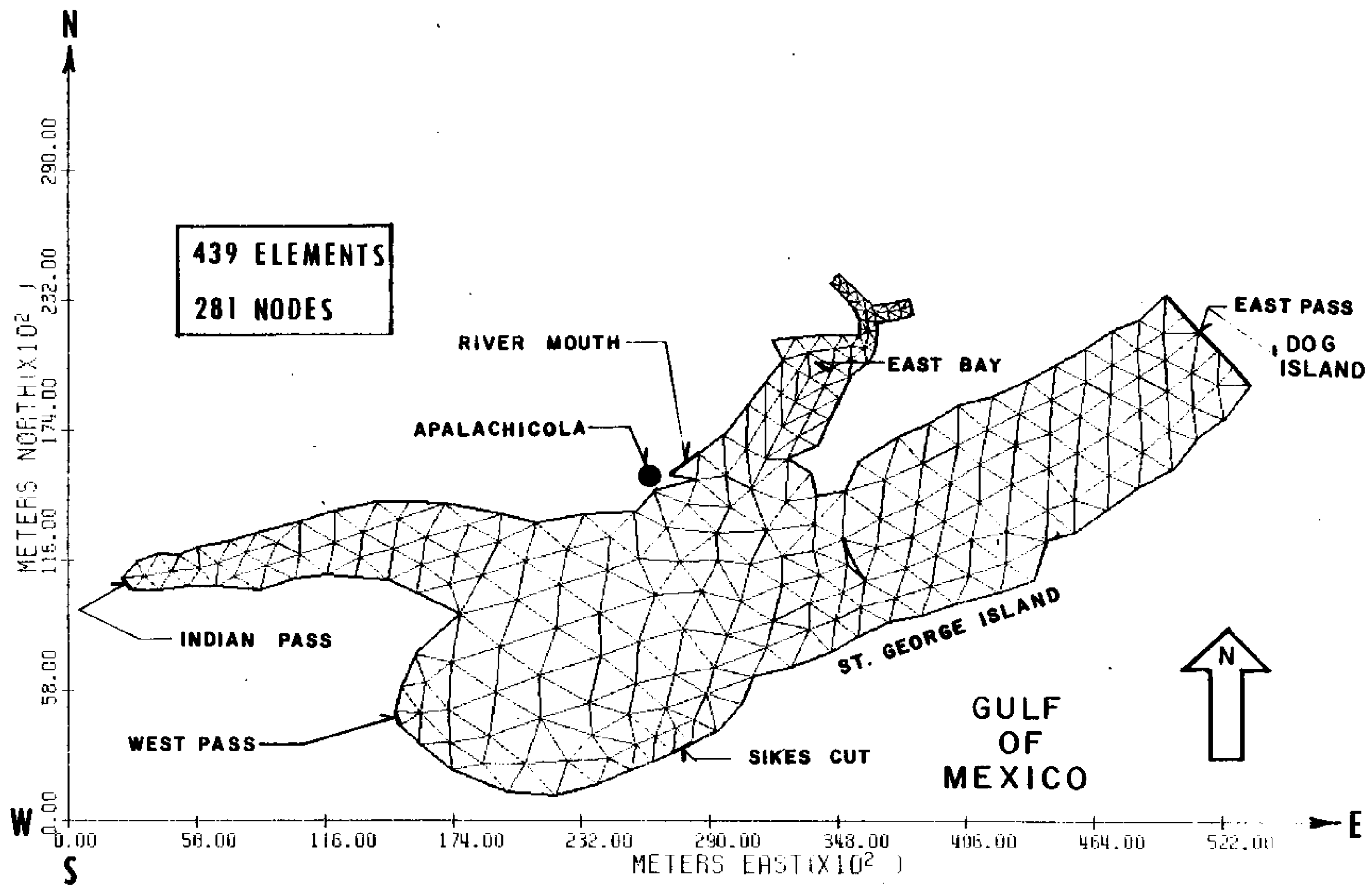


Figure 3.1. Finite Element Grid System of Apalachicola Bay Used in this Study.

1) Massachusetts Bay - (Briggs and Madsen, 1973); (Christodoulou et al., 1974); (Connor et al., 1973); and (Parker and Pearce, 1975).
2) Narragansett Bay - (Connor and Wang, 1974); (Swanson and Spaulding, undated).
3) Great Bay, N.H. - (Cellikol and Reichard, 1976); (Swanson et al., 1977).
4) Mareton Bay, Australia - (Steele et al., 1977).
5) Biscayne Bay, Florida -(Sengupta et al., 1978); (Swakon and Wang, 1977).
6) Lake Pontchartrain - done at Louisiana State University.

All of the known successful applications appear to have been made by M.I.T. trained personnel, with the exceptions of the Lake Pontchartrain study and this University of Florida study.

These latter two studies, therefore, reflect the degree to which the models are available to the public. Both LSU and UF personnel have been able to run the programs, but it was concurred in private communications that the package is, as yet, somewhat underdocumented for most users. In some instances, the lack of documentation merely forces the user to better understand the model before using it. In some cases, however, required units or other items are unclearly specified and can cause considerable confusion. In any event, current model use requires personnel knowledge in both hydrodynamics and computer programming. Based, again, on a comparison of respective progress at LSU and UF, it appears that a training period of 6 to 8 months full time is necessary before satisfactory results and progress can be obtained with this model package. This is not inherently unreasonable, but it should underline the necessity of establishing continuity in terms of personnel capability.

An excellent outline of model properties and capabilities at a lay level, including potential user applications, is given in an M.I.T. Marine Industry Advisory Services Opportunity Brief.

The models are currently available from the Parsons Laboratory, Department of Civil Engineering at M.I.T., and from Dr. John Wang, Department of Ocean Engineering at the University of Miami. Users manuals are also available from M.I.T. Acquisition costs for both models (CAFE and DISPER), (not debugged) were about $70.00. This reasonably covers cost in 1978 dollars.

The tape containing the CAFE-1 and DISPER-1 models modified for the Apalachicola Bay is available from the Hydraulic Laboratory, University of Florida. A copy of this tape is attached as Appendix B to this report in its original copy submitted to the Florida Sea Grant.

3.1.2 Equations for CAFE-1

Wang and Connor (1975) present the most complete derivation of the equations. In the process of equation development, averaging over time (to remove turbulence terms) and space (to reduce the equations to two dimensions) occurs. Such averaging always introduces additional coefficients into the equations and changes the meaning of many terms. For example, dispersion coefficients will include effects of depth averaging as well as turbulent diffusion. Graham, Daniels, and Christensen (1979) follow the outline of Swakon and Wang (1977) to present the basic equations. Several variables must be introduced, including vertically integrated discharges per unit width (q_x and q_y) in the two coordinate directions (x and y) and surface displacement above mean low water, η.

The total depth, H, is then given by

$$H = \int_{-h}^{\eta} dz = h + \eta \tag{3.1}$$

in which

z = vertical coordinate

h = depth at mean low water (MLW)

The basic equations can be written as follows:

Conservation of mass:

$$\frac{\partial H}{\partial t} + \frac{\partial q_x}{\partial x} + \frac{\partial q_y}{\partial y} = q_I \tag{3.2}$$

Conservation of momentum in x-direction:

$$\frac{\partial q_x}{\partial t} + \frac{\partial (uq_x)}{\partial x} + \frac{\partial (uq_y)}{\partial y} - fq_y + \frac{1}{\rho}\left[\frac{\partial}{\partial x}\int_{-h}^{\eta} p dz - p^s \frac{\partial H}{\partial x} - p^b \frac{\partial h}{\partial x}\right] - \frac{\partial}{\partial x}(F_{xx}) - \frac{\partial}{\partial y}(F_{xy}) + \frac{\tau^s - \tau^b}{\rho} - \bar{M}_x = 0 \tag{3.3}$$

Conservation of momentum in y-direction:

$$\frac{\partial q_y}{\partial t} + \frac{\partial (vq_x)}{\partial x} + \frac{\partial (vq_y)}{\partial y} + fq_x + \frac{1}{\rho}\left[\frac{\partial}{\partial y}\int_{-g}^{\eta} p dz - p^s \frac{\partial H}{\partial y} - p^b \frac{\partial h}{\partial y}\right] - \frac{\partial}{\partial y}(F_{xy}) - \frac{\partial}{\partial y}(F_{yy}) + \frac{\tau^s - \tau^b}{\rho} - \bar{M}_y = 0 \tag{3.4}$$

in which

f = Coriolis parameter = $2 \cdot \omega_{earth} \cdot \sin 29°$ corresponding to the latitude of Apalachicola Bay

p = pressure

p^s = atmospheric pressure

p^b = bottom pressure

τ^s = surface stress

τ^b = bottom stress

ρ = local density of water in the bay

q_I = volume addition rate

t = time

$u = q_x/H$ = local mean velocity in x-direction (3.5)

$v = q_y/H$ = local mean velocity in y-direction (3.6)

x,y = Cartesian coordinates (horizontal)

F_{xy}, F_{yy} = internal specific stress terms (stress/density), sometimes termed "turbulent eddy viscosity coefficients"

$\overline{M}_x, \overline{M}_y$ = momentum addition per unit horizontal area

A Bouissinesq approximation is used in the pressure terms, viz:

$$\frac{\partial}{\partial x} \int_{-h}^{\eta} p dz - p^s \frac{\partial \eta}{\partial x} p^b \frac{\partial h}{\partial x} \sim \rho_o gH \frac{\partial \eta}{\partial x} + H \frac{\partial p^s}{\partial x}$$

$$+ \frac{1}{2} gH^2 \frac{\partial \Delta p}{\partial x} \tag{3.7}$$

in the x-direction. A similar equation is derived for the y-direction. Here

$$\rho(x,y,t) = \rho_o + \Delta \rho(x,y,t) \tag{3.8}$$

with the usual definitions. For practical purposes the effect of the atmospheric pressure usually induces a 1 cm change in sea level; this may not be readily justified. The reason for doing so is simply that these data are not available. Since most estuaries are small in scale compared to weather systems, only a constant error results. If the MLW is assumed to be a flat arbitrary datum (which, again, for practical purposes is a necessary assumption in most cases), then no detectable error results.

The term $\frac{1}{2} g H^2 \frac{\partial \Delta p}{\partial x}$ is also often ignored. Based on the premise that most passive pollutants do not change the density field. An exception, of course is salinity.

The internal stress coefficients, can be written as

$$F_{ij} = \frac{E_{ij}}{(2\delta_{ij})} \left(\frac{\partial q_i}{\partial x_j} + \frac{\partial q_j}{\partial x_i}\right) \tag{3.9}$$

where E_{ij} are the turbulent eddy viscosity coefficients, which can be manipulated. In practice, the terms E_{ij} serve several functions, including:

1) Expressing "true" turbulent eddy viscosity (assuming the validity of a mixing length analogy).
2) "Internalize" Reynolds stress terms lost in averaging over the depth.
3) "Internalize" horizontal Reynolds stress terms of such scale that the grid cannot resolve them.
4) Expressing true molecular viscosity. This component is of course of negligible importance at these scales.
5) An adjustment coefficient to calibrate the model.
6) Help stabilize the model.

Addition of the F_{ij} terms essentially adds some elegance to the model. Leendertse's (1967) 2-D finite-difference model neglected these terms. They were included by Wang and Connor (1975) because

"We feel that the inclusion of F_{ij} has several attractive properties. It allows for internal friction and thereby energy dissipation, provided E_{ij} is positive; it does represent actual physical processes (although not accurately) and it is particularly suitable for damping short wave noise generated by numerical methods."

Note that no explicit stability criteria have yet been developed for CAFE-1, at least as reported by Wang and Connor (1975), so inclusion of a damping term for high-frequency noise is very useful. In comparison, explicit stability criteria are known for a finite-difference grid of constant element size.

The model does not seem particularly sensitive to values of F_{ij} as noted by Connor and Wang (1975). A comparison of E_{ij} values will be presented shortly. A significant test to determine whether a numerical model application is credible and predictive lies in the values given the "adjustment coefficients", such as E_{ij} and n (Manning roughness coefficient) in CAFE-1, and the dispersion coefficient D_{ij} in DISPER-1. If these coefficients have values which are reasonable in relation to values used in analytic hydrodynamic approximations (taking the grid size into consideration), then some confidence can be placed in the predictability of the model. If extraordinary values of "adjustment coefficients" have to be used to match the model output to measured data, then the application is likely unique (or incorrect). This comparison may be a more valid "bottom line" test than a comparison of model output to measured data.

Note that the gradient terms ($\partial q_i/\partial x_j$, ...) in Equation (3.9) are approximated by finite values on the grid, and error results if the grid is non-zero in size. The values of F_{ij} and E_{ij} are therefore functions of the local grid scale as well as hydrodynamics.

The bottom stress terms in Equations (3.3) and (3.4) use the generally accepted quadratic approximation:

$$\tau^b_{x_i} = C_f \, \rho_0 \, (q^2_{x_i} + q^2_{x_j})^{1/2} \frac{q_{x_i}}{H^2} \tag{3.10}$$

in which

$$C_f = \frac{n^2 g}{H^{1/3}} \tag{3.11}$$

n = Manning's "n"

and g = acceleration due to gravity.

Therefore,

$$\tau^b_{x_i} \sim \frac{1}{H^{7/3}} \tag{3.12}$$

For shallow estuaries then, significant improvement in the output quality is achieved by computing the velocities using instantaneous values of total depth, since the tidal range is a significant proportion of total depth. Note that Manning's "n" is another "adjustment coefficient". Reasonable values are well known however, and lie in the range 0.020 to 0.040. [Most values of n have been computed for rivers. However, some study is required to find appropriate values for flow over oyster bars and shell-littered bottoms.]

The wind stress term τ^s/ρ warrants qualitative discussion. Recent oceanographic studies have indicated that wind is a far more important energy input source to estuaries then had heretofore been surmised (Weisberg, 1976). Most Florida estuaries can be considered to be wind dominated. Work at the University of Florida in coastal canals indicates wind is much more influential in flushing than tidal action (see Morris, Walton, and Christensen, 1978). Tidal measurements by Hydraulic Lab personnel show that wind-set up can be up to about 3 times the tidal range.

The wind stress term in CAFE-1 is of the accepted quadratic form:

$$\tau^s = \rho_{air} C_D U_{10}^2 \tag{3.13}$$

where

ρ_{air} = air density

C_D = a dimensionless drag coefficient

U_{10} = air velocity at 10 meters above water surface, in m s^{-1}

The form given for C_D is

$$C_D = (1.1 + 0.0536\ U_{10}) \times 10^{-3} \tag{3.14}$$

This is based essentially on empirical data. Discussion of development and validity of Equation (3.14) and (3.15) is given by Briggs and Madsen (1973). Properly setting the boundaries may be a problem when there is a significant wind setup. This usually requires an independent study of setup properties. One approach is to run the model with no tide and adjust the boundaries so a smooth setup is established and then superpose tides on the MLW level. Alternatively, real-time wind and tidal data can be input.

Final forms of Equations (3.2) to (3.4) are developed by inserting these approximations:

Conservation of mass:

$$\frac{\partial H}{\partial t} + \frac{\partial q_x}{\partial x} + \frac{\partial q_y}{\partial y} = 0 \tag{3.15}$$

Conservation of momentum in x-direction:

$$\frac{\partial q_x}{\partial t} + \frac{\partial (q_x{}^2/H)}{\partial x} + \frac{\partial (q_x q_y/H)}{dy} - fq_y$$

$$+ g\ H \frac{\partial \eta}{\partial x} + \frac{H}{\rho} \frac{\partial p^s}{\partial x} + \frac{gH^2}{2\rho} \frac{\partial \Delta\rho}{\partial x}$$

$$+ \frac{\rho_{air}}{\rho_o} C_D |U_{10}| U_{10x} - C_f (q_x^2 + q_y^2)^{1/2} \frac{q_x}{H^2}$$

$$- \frac{\partial F_{xx}}{\partial x} - \frac{\partial F_{yx}}{\partial x} - \bar{M}_x = 0 \qquad (3.16)$$

Conservation of momentum in y-direction:

$$\frac{\partial q_y}{\partial t} + \frac{\partial (q_x q_y/H)}{\partial x} + \frac{\partial (q_y^2/H)}{\partial y} + f q_x$$

$$+ g H \frac{\partial \eta}{\partial y} + \frac{H}{\rho} \frac{\partial p^s}{\partial y} + \frac{\partial H^2}{2\rho} \frac{\partial \Delta\rho}{\partial y}$$

$$+ \frac{\rho_{air}}{\rho_o} C_D |U_{10}| U_{10y} - C_f (q_x^2 + q_y^2)^{1/2} \frac{q_y}{H^2}$$

$$- \frac{\partial F_{xy}}{\partial x} - \frac{\partial F_{yy}}{\partial y} - \bar{M}_y = 0 \qquad (3.17)$$

Numerical approximation procedures used in CAFE-1 will not be discussed in detail here. For details see Wang and Connor (1975).

3.1.3 Turbulent Eddy Viscosity Coefficient E_{ij}

The eddy viscosity coefficient E_{ij} is the major variable parameter by which the engineer can adjust the model results to fit a data set. For this reason a separate section is devoted to this parameter here. Model validity and predictability therefore hinge on the credibility of the values assigned to F_{ij}. A brief literature review was made to determine what reasonable values might be. It has been shown that F_{ij} is a function both of the velocity field and characteristics of the numerical solution grid.

A "rough" formula for estimating E_{xx} is given by Wang and Connor (1975), as

$$E_{ii} \sim \alpha\ g\ \frac{\hat{\eta}}{\hat{u}_i}\ \Delta\ell_i \qquad (3.18)$$

where

$$\begin{aligned} \alpha &\approx 0.1 \text{ to } 0.01 \\ g &= 9.81 \text{ m s}^{-2} \qquad (3.19) \\ \hat{\eta} &= \text{expected tidal range} \\ \hat{u} &= \text{expected velocity} \\ \Delta\ell &= \text{characteristic grid length} \end{aligned}$$

For $\alpha \leq 0.02$ the only effect of this term is to dampen short wave noise.

Note that $\hat{u}_i$, ℓ_i, E_{ii} refer to components in direction i. A better approximation for the velocity field contribution might be the difference in characteristic velocities across $\Delta\ell_i$.

Few authors have provided any insight into the rational for choosing the eddy viscosity coefficient values they have used. Some sample values are produced in Table 3.1. Since grid sizes varied so greatly in different applications, a nondimensionalized value, E^*_{ii}, defined by

$$E^*_{ii} = \frac{E_{ii}\ \Delta t}{\Delta\ell_i^{\ 2}} \qquad (3.20)$$

is introduced as more appropriate for comparison. It can be seen in the table that values for this parameter range from .0025 to .002, with credible values being in the range .001 to .05 (depending on the value of α used). As noted by Wang and Connor (1975), ideally E_{ii} should be minimized with α having a highest practical value for damping of about 0.02. High values of E^*_{ii} indicate the modeler may have forced stability on the system, although many other factors may also be important in such cases.

Table 3.1. Values of Turbulent Eddy Viscosity Coefficients for Numerical Models.

Source	$\Delta \ell_i$, m	t, sec	$\hat{n}$, m	$\hat{u}_i$, m	E_{ii}, m^2s^{-1}	E^*_{ii}
(Steele et al., 1977)	250-500	100	2	0.5	500	0.2-0.8
Great Bay, N.H. (Cellikol and Reichard, 1976)	250	10	1.2	1.5	36	0.0057
Portsmouth Harbor, N.H. (Cellikol and Reichard, 1976)	150-250	5	1.25	0.5	20	0.0016-0.0044
Massachusetts Bay (Connor and Wang, 1977)	5000	100	2	0.2	10,000	0.04

For the Apalachicola grid some reasonable estimates are, for the smallest element, with low velocities

$$\alpha = 0.02$$

$$g = 9.81 \text{ m s}^{-2}$$

$$\hat{\eta} \sim 1 \text{ m}$$

$$\hat{u} \sim 0.1 \text{ m s}^{-1}$$

$$\Delta \ell_i \sim 350 \text{ m at least}$$

$$E_{ii} \approx (0.02)\ (34335) = 686.7 \text{ m}^2\text{s}^{-1}$$

and

$$\frac{E_{ii}\ \Delta t}{\Delta \ell_i^2} = \frac{686.7 \cdot 60}{350} = 0.33$$

For the largest elements, with highest velocities,

$$\hat{u} \sim 0.5 \text{ m s}^{-1}$$

$$\Delta \ell_i \sim 3000 \text{ m}$$

$$E_{ii} = (0.02)\ (58860) = 1177 \text{ m}^2\text{s}^{-1}$$

and

$$\frac{E_{ii}\ \Delta t}{\Delta \ell_i^{\,2}} = \frac{1177 \cdot 60}{3000^2} = 0.0078$$

In fact, values of $E_{xx} = E_{yy} = 40 \text{ m}^2\text{s}^{-1}$ and $E_{xy} = 2\text{- m}^2\text{s}^{-1}$ were selected for subsequent model runs to minimize impact of this parameter and assure a search to define the important physical variables in the system. Values of E^*_{ii} for these values of E_{ii} are

1) smallest of elements

$$E^*_{ii} = .02$$

2) largest elements

$$E^*_{ii} = .0002$$

In general the personnel on this project preferred grid manipulation to increasing E_{ii} as a means to achieve stability in CAFE-1. The decision was made to use the lowest appropriate values found in the literature and design a stable grid around these. The procedures used to obtain a stable grid will be discussed in the next section.

3.1.4 Application and Debugging of CAFE-1 Model for Apalachicola Bay

Application of the CAFE-1 model to Apalachicola Bay turned out to be a trial and error process which took somewhat longer than anticipated. A finite learning curve exists however, since it is now possible to change the grid in a timespan of 2-3 days, whereas it took about 4 months to get the first successful run.

Apalachicola Bay is complicated by the fact that there are several tidal inlets and several river inflow locations. The application was further complicated by the fact that the dispersion model required good resolution of East Bay and East and West Bayous. This required an extreme range of element sizes, which tends to make the model unstable.

Finding a stable grid is something which was found best learned by trail. It becomes intuitive to some degree, and this is a drawback of the model in its current form. An initial "ideal" grid proved to be completely unstable. Then a grid was made in which elements were made more equilateral, and element sizes varied slowly. This was gradually modified to the working grid by changing several unstable areas. To accomplish this the graphics routines were found very helpful.

Unlike DISPER-1, CAFE-1 tends to die quite rapidly when an instability occurs. The initiation of the instabilities could be traced by reviewing velocities at all points for time steps leading up to the instability. This is, however, very inefficient. Therefore, graphics routines for the Gould (essentially the same as CALCOMP) plotter were developed to enable plotting velocity vectors at desired time steps. It was then very easy to see where instabilities occurred. The problem was usually one of the following items:

1) improper node or element definition
2) total depth less than about 1 dm at low water
3) grid changed size too rapidly
4) irregular triangle shape
5) grid elements too large in zone of rapid velocity change
6) too rapid change of depth.

Since instabilities tended to occur sequentially, the procedure usually consisted of fixing one problem at a time. As the total number of potential instabilities was not known, the process was discouraging at times.

Despite the fact that an implicit time step routine is used in CAFE-1, there appears to be a limit on the time step imposed by stability considerations. This criterion seems to take the form of the Courant-Friedrichs-Lewy (CFL) condition. The two-dimensional form of the Courant number is given by Cunge (1977) as

$$C_r = \frac{\Delta t}{\Delta x} \sqrt{2gH} \qquad (3.21)$$

In theory, an implicit scheme should be stable for any value of C_r, even considerably greater than 1, although the accuracy of the solution will generally decrease as C_r approaches higher values. The theoretical stability of the model is, however, tempered by real physical features. For example, Cunge (1977) discusses the Leendertse (1967) scheme, which is considered a strictly non-dissipative, second-order accuracy scheme. This means that no numerical damping of wave amplitudes will occur, which is desirable for real waves. However, this also means that discontinuities, perturbations, rough geometry (rapid depth changes, etc.) will create numerical waves which are not damped. Therefore, a theoretically stable scheme may become unstable in some applications. It should also be noted that the theoretical stability limits are always obtained by a linear stability analysis of the von Neumann type which can best be considered a guide to stability of the nonlinear equation system.

Considerable numerical experimentation led to the adoption of a practical CFL-type criterion given by

$$\Delta t \leq 0.7\ \Delta x_o/\sqrt{2g\ H_o} \tag{3.22}$$

for this model in which x_o and H_o refer to the grid location giving the critical value for Δt.

It was found that for all grids thus far used, Equation (3.22) yielded values close to 60 seconds, and a time step of 60 seconds for CAFE-1 runs was in fact found acceptable and will be used for all results presented in this report.

3.2 The DISPER-1 Model

The selection of DISPER-1 was rather direct once CAFE-1 was selected as the hydrodynamics model. It is 2-D, real-time, finite-element, compatible with CAFE-1, and readily available. Because advection dominates dispersion in tidal systems, a real-time model is required. This need is particularly strong given the transient character of stormwater quality and quantity. Availability of real-time capability will be extremely beneficial when any biological, chemical, or other time-dependent constituent changes and interactions are added to the model at a later date.

DISPER-1 is a real-time, 2-D, vertically-averaged finite element model for solution of the convective-diffusion equation given hydrodynamic inputs from another source (in this case from CAFE-1). The model is described by Christodoulou et al. (1976), Leimkuhler et al. (1975), and in a user's manual by Pagenkopf et al. (1976).

3.2.1 Equations and Boundary Conditions for DISPER-1

The model solves the classicial convective-diffusion equations: Following Leimkuhler et al. (1976)

$$\frac{\partial c}{\partial t} + \frac{\partial}{\partial x}(uc) + \frac{\partial}{\partial y}(vc) = - \frac{\partial}{\partial x}\ {}_x - \frac{\partial}{\partial y}\zeta_y + P_o \qquad (3.23)$$

in which

$$\zeta_x = - \rho H D_{xx}\frac{\partial c}{\partial x} - \rho H D_{xy}\frac{\partial c}{\partial y} \qquad (3.24)$$

$$\zeta_y = - \rho H D_{xy}\frac{\partial c}{\partial x} - \rho H D_{xy}\frac{\partial c}{\partial y} \qquad (3.25)$$

$$c = \rho \bar{c} H \qquad (3.26)$$

where

$\bar{c}$ = average concentration of a constituent

H = total depth

ρ = density of water

u,v = vertically averaged velocities in x and y directions, respectively

c = vertically integrated concentrations

P_o = sources and sinks of mass

D_{ii} = dispersion coefficient

Note that Equation (3.23) expresses conservation of mass of the constituent of interest. Values of u and v came from CAFE-1.

Either a fixed concentration or a fixed mass flux can be specified as a boundary condition. These may be specified on elements or nodes or some combination thereof.

It is important to bear in mind that this is a finite element scheme when loading the boundaries. Linear interpolation functions are used, so if a smooth unit load of 1 kg s^{-1} is to be placed across 3 points, then loading will have to be assigned as 0.25 kg s^{-1} on each of the outer points and 0.50 kg s^{-1} on the central point of the three. Also, if the grid has a depth of 2 m, then the initial concentration of the above scheme will be 1/2 that for a grid of 1 m depth. This is because the model solves for depth-intergrated values, as noted in Equation (3.26).

At the present time boundary conditions may vary in DISPER, but only if they are specified explicitly over the tidal cycle or over time. This is inconvenient for many problems (and especially for the determination of salinity) since the solution at the boundary must be specified before it is known. Known applications avoid this problem by assigning a decay value, or by having the source sufficiently weak that complete dilution occurs, so that c is equal to zero at all times at the boundary. Another useful approach is the floating boundary condition developed by Dailey and Harleman (1972) which sets the boundary concentrations at ocean value during flood tide, and specifies that the gradient of the dispersive flux during ebb tide remains constant.

3.2.2 Stability and Convergence of DISPER-1

The best work in the area of stability and convergence of DISPER-1 has been done by Christodoulou et al. (1976), and experience at the University of Florida has helped strengthen their findings for application of DISPER-1 to Apalachicola Bay. In the dispersion model, three factors combine to change constituent concentrations. These are advection (represented by the velocity, u), dispersion (represented by the dispersion coefficient, D_{ii}), and decay (represented by the appropriate decay or reaction coefficients). It has been found that typical decay terms create slower changes than the other two terms and can generally be neglected in stability analyses. Christodoulou et al. (1976) found that the total effect of advection and dispersion could be represented in defining a "safe" region given by the following inequality.

$$(1.22 \frac{u \Delta t}{\Delta x})^2 + (8 \frac{D_{ii} \Delta t}{\Delta x^2})^2 < 1 \qquad (3.27)$$

It should be noted that Equation (3.27) is based on a theoretical analysis assuming very regular and equilateral triangles and verification has occurred only on moderately irregular grids. For highly irregular grids, the allowable time step may be considerably below that given by Equation (3.27). Equation (3.27) can be converted to

$$\Delta t \leq [(1.22 \frac{u}{\Delta x})^2 + (8 \frac{D_{ii}}{\Delta x^2})^2]^{-0.5} \qquad (3.28)$$

As an example, for element sizes of about 400 mm, D_{ii} of 100 $m^2 s^{-1}$, and a maximum velocity of about 1.5 m s^{-1}, Equation (3.28) yields a value of 147 s. This, too, may need to be further reduced due to other problems. However, in general it is true that DISPER-1 is stable at longer time steps than CAFE-1.

Once the models have been made stable for a given grid, then one must turn to the question of accuracy of the solution or convergence to the true solution. No specific criteria have been developed in this regard for CAFE-1, although it is generally believed that a stable solution is also accurate unless unexplained oscillations persist in any portion of the flow region.

Christodoulou et al. (1976) proposed an accuracy criterion for DISPER-1, given by inequality (3.29)

$$\Delta x < \frac{2\, D_{ii}}{u} \tag{3.29}$$

Inaccuracies in DISPER-1 exhibit themselves as negative concentrations and as ocillating values of concentrations. For $D_{ii} = 100\ m^2 s^{-1}$ and a maximum velocity of $u = 1.5\ m\ s^{-1}$, it can be seen that Equation (3.29) yields a very small element size of about 130 m. If in fact such a small element size were chosen, then values of the time increment would be drastically lowered, as shown by Equation (3.29) for DISPER-1 and Equation (3.22) for CAFE-1.

Fortunately, Equation (3.29) applies primarily in areas of high concentration gradients and high concentrations. In regions far from the sources, where concentrations remain lower, a larger length scale may function satisfactorily. It should be realized, however, that the grid size may have to be modified, and hence the time step, to eliminate oscillations and non-negligible negative concentrations.

Several other features may play a role in determining model behavior but have not been cast in any quantitative criterion. A few of interest here will be mentioned. It has been shown that the schematization of the source(s) in DISPER-1 is very important. In one example given by Christodoulou et al. (1976), the criteria given by Equations (3.28) and (3.29) were both met. In two runs, all parameters were the same except that the source was distributed over two elements in one run and over eight elements in the other run. The run with eight elements for the source gave completely satisfactory results, while those from the other runs exhibited excessive oscillation. Therefore sources should be distributed over several elements, but it should be realized that this often means that model predictions very near the source may be less valid.

The element shapes and gradation of element sizes have been observed by Hydraulic Laboratory personnel to be very important also. Elements too different from an equilaterial triangle may cause problems. In addition, problems may occur where element sizes change too rapidly. This also includes too rapid a change in depth, even where element sizes and shapes are fairly regular.

A factor in stability and accuracy is the initial condition chosen for the bay. A common approach used in earlier Apalachicola Bay runs is the so-called cold-start, with zero concentrations, e.g., specified in DISPER-1. The model can, however, be operated in a hot-start mode, where concentrations are specified throughout the grid at time zero. Of course, in either case, the model is run sufficiently long (through several tidal cycles) to remove any bias provided by the assumed initial conditions. However, instabilities or inaccuracies could occur due to the extreme gradient of concentration setup at the onset of model operation. If this occurs, it may be more economical to specify a realistic initial concentration field as opposed to severely restricting element size and time increment.

4. MODEL VERIFICATION

As noted in Section 3, the two models being used have been verified by application to other waterbodies and comparing results to measured data. Of course, as is always the case, verification may be in the eye of the beholder. In the following, verifications of the models as used in the Apalachicola area will be discussed.

4.1 Verification of CAFE-1

4.1.1 Field Data

Two primary types of data were obtained from the field: (1) tidal information at various points in the bay and (2) water velocity measurements. In addition, the wind velocity was measured several times during the data collection process.

Most of the field data to be discussed in this report were gathered from September 15 through September 26, 1980, and from November 7 through November 9, 1980.

4.1.1.1 Tide Recordings. Tide gages were place at each of the four ocean boundaries: East Pass, Sikes Cut, West Pass, and Indian Pass. The tides recorded at these gages were used as input boundary information to the model.

In addition, tide gages were installed at two internal points in the bay (points A and B in Figure 4.1). The recordings from these two tide gates were used as a comparison with the model results. Figure 4.2 shows a tide gage and recorder in place on a private dock at Indian Pass. A sample recording of the tide at East Pass is shown in Figure 4.3.

Additional tidal information was obtained from NOAA.

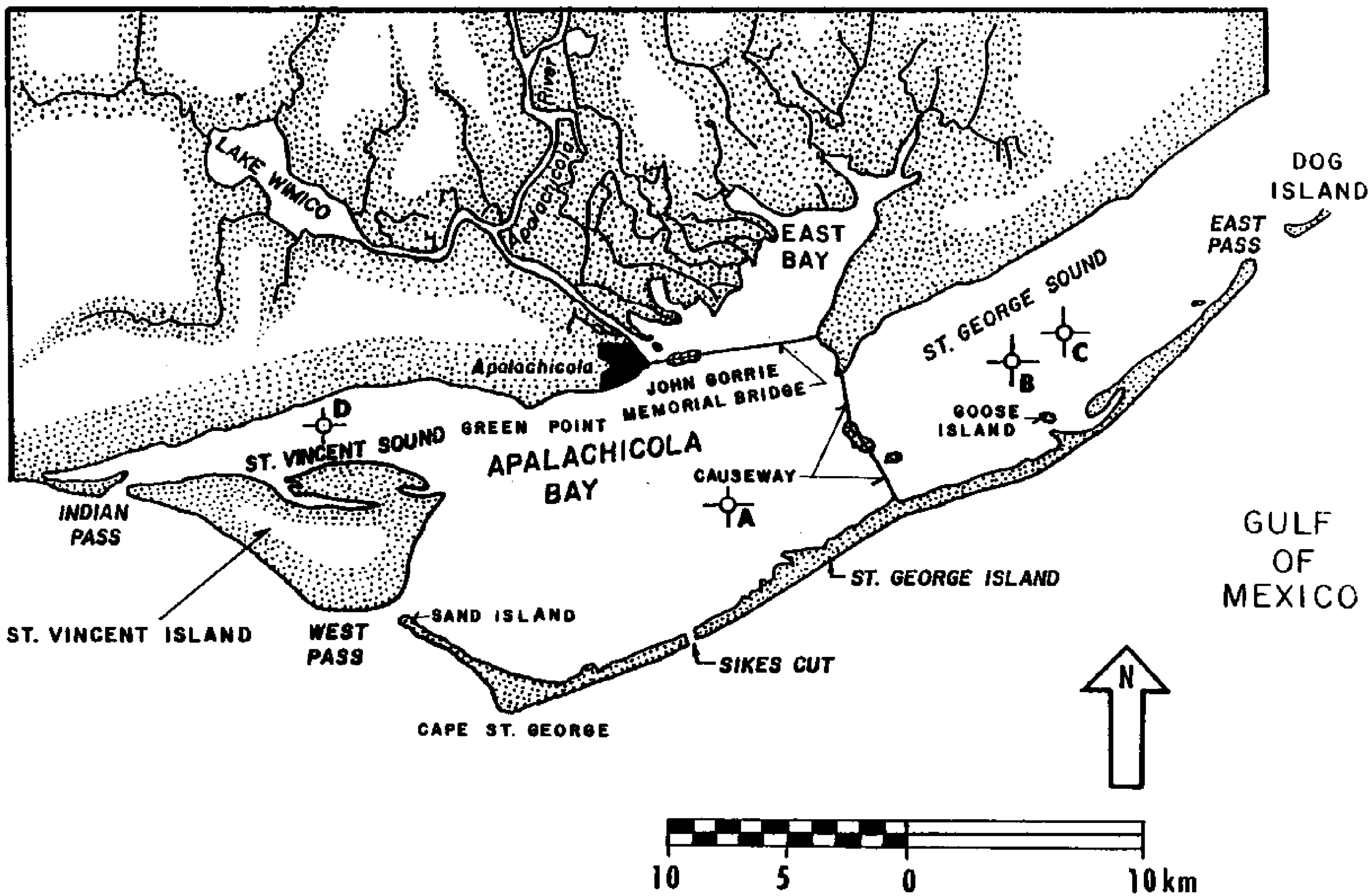


Figure 4.1. Location of Verification Points in Apalachicola Bay.

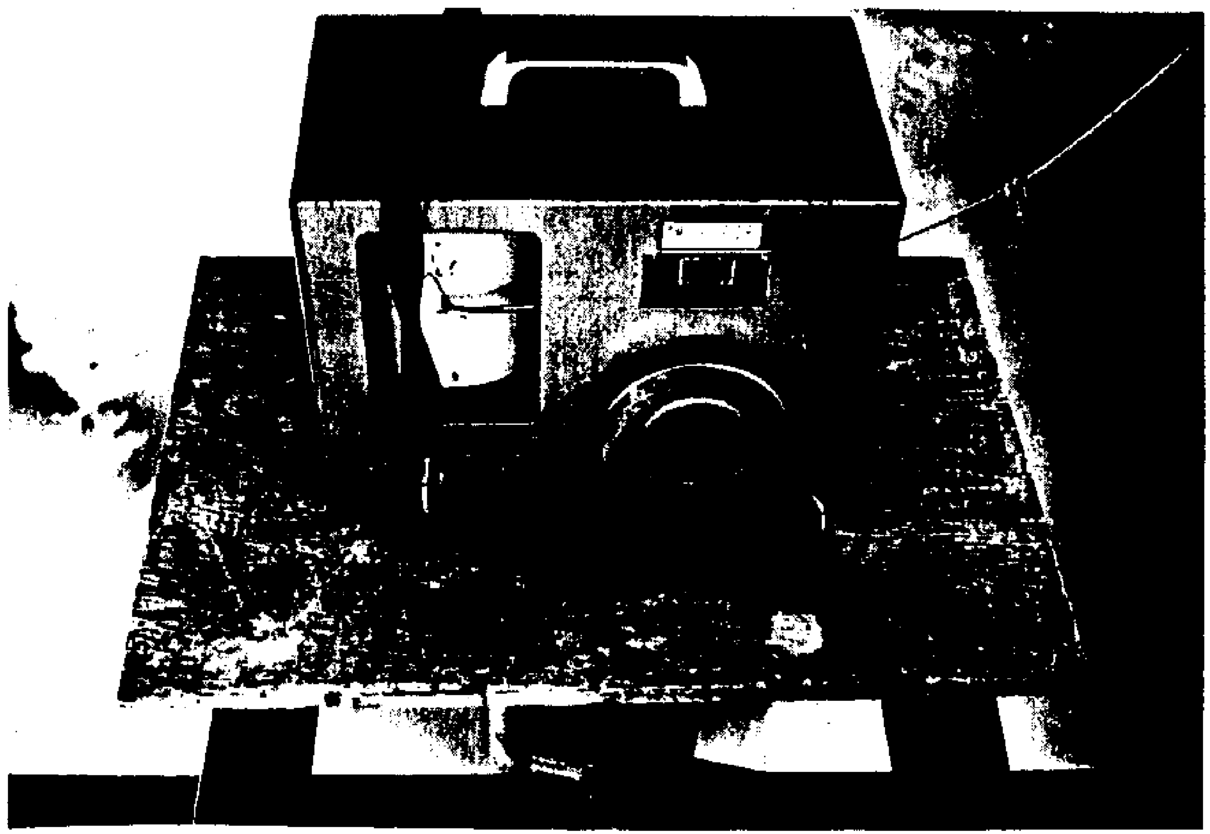


Figure 4.2. Tide Gage and Recorder in Place at Indian Pass.

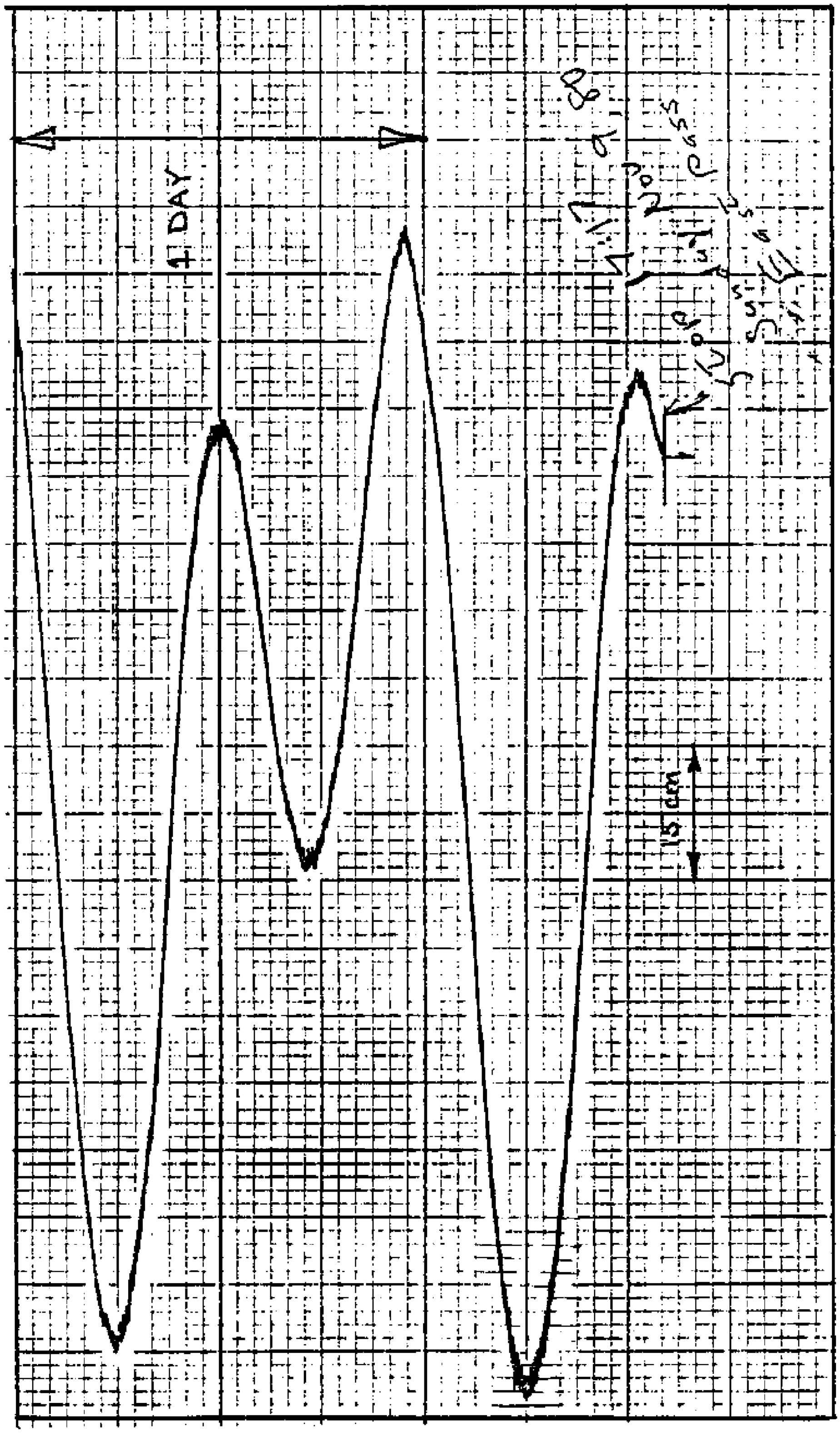


Figure 4.3. Sample Recording from Tide Gage at East Pass.

4.1.1.2 Velocity Measurements. All velocity measurements were taken from a boat using a V "Arkansas" Ott Meter (see Figures 4.4 and 4.5). Logarithmic velocity profiles were assumed, so the velocity readings to be compared with the model output were taken at 36.8% of the total depth from the bottom (which is the location of the spatial mean velocity for a logarithmic velocity profile). Velocities were also recorded at other depths so that velocity profiles could be plotted and the assumption of logarithmic velocity profile checked.

At points C and D (Figure 4.1) measurements were taken at short intervals for periods of about four hours. These values were used as a comparison with the model results. Velocity profiles were also measured at several other points in the bay.

Flow direction was measured with a compass after hoisting the Ott Meter to an elevation where it could be seen (see Figure 4.6). It is assumed that the flow direction is the same at all depths below the water surface.

4.1.2 Model Input for Verification Runs

4.1.2.1 Grid Configuration. The finite element grid shown in Figure 3.1 was used for all of the computer runs to be discussed in this report. It contains 281 nodes and 439 elements.

This particular grid was chosen after experimentation with several grids because of its many desirable characteristics. First, the element size is small enough to provide an accurate representation of the bay. Second, most of the triangles are approximately equilateral and there is no rapid change in element size. This is of particular importance because rapid change in element size as well as irregular triangles, tends to produce instabilities which cannot be predicted by quantifiable stability criteria as discussed earlier.

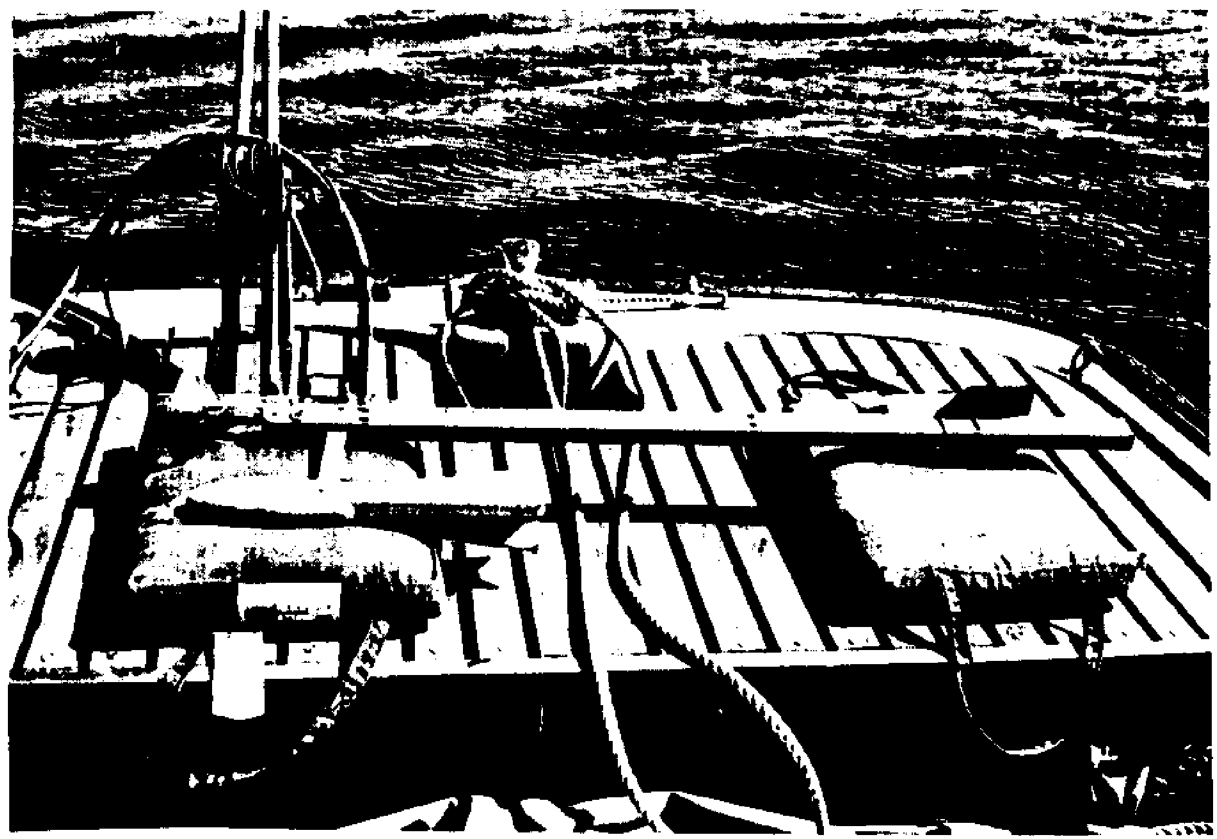


Figure 4.4. Ott Propeller Meter Used for Velocity Measurements in Apalachicola Bay.

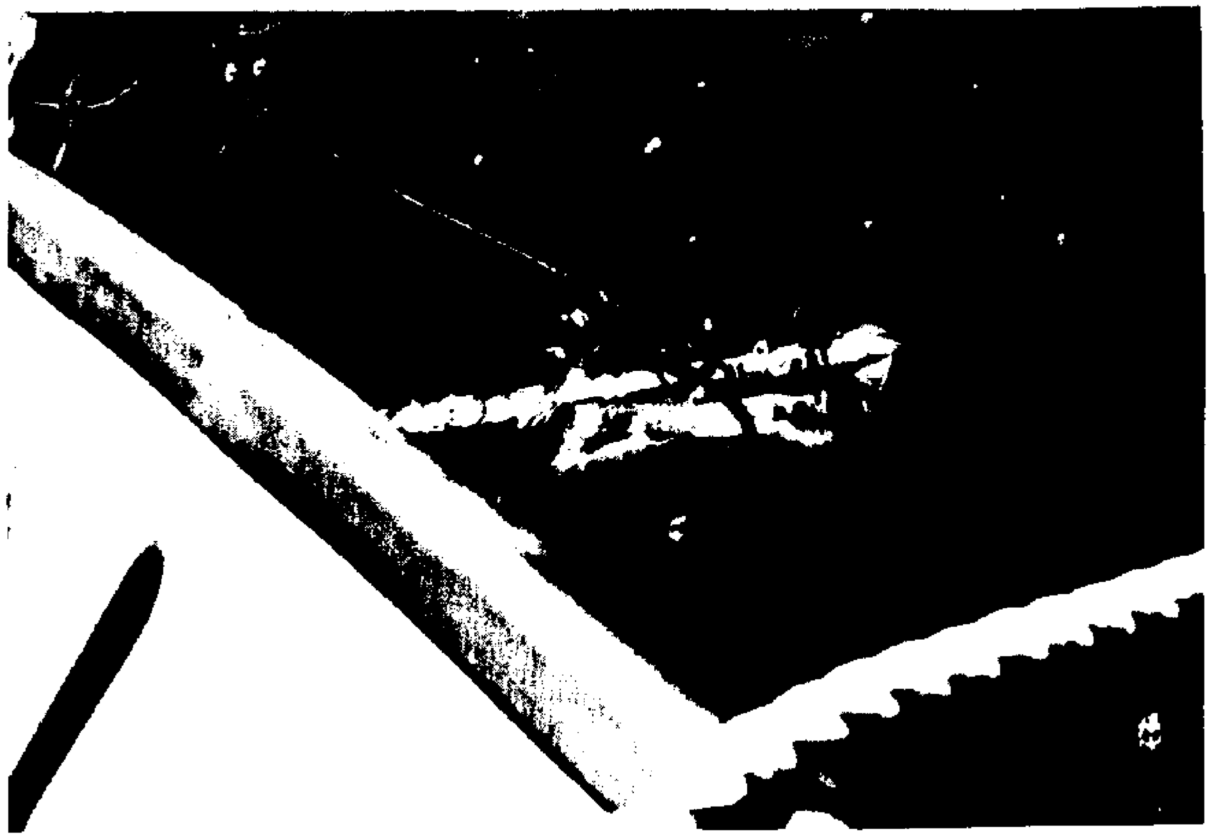


Figure 4.5. Ott Propeller Meter Near Water Surface.

Figure 4.6. Observation of Direction of Water Flow.

The remaining reasons for choosing this grid are related to the cost of running the model. This cost is roughly proportional to the number of elements and inversely proportional to the timestep.

The timestep was chosen to be 60 seconds in accordance with the earlier discussed stability criteria. In addition, the output from CAFE-1 is used as input to a water quality model and 60 seconds is a convenient interval for transferring this information.

4.1.2.2 Turbulent Eddy Viscosity Coefficients. As stated earlier, internal stresses from turbulence and velocity shear are represented in the model in the form of Equation (3.9). Since there is no way to actually measure these stresses, the literature review provided reasonable values for the eddy viscosity coefficients. The values currently being used are the following:

$$E_{xx} = 40.0 \ m^3 s^{-1}$$
$$E_{yy} = 40.0 \ m^3 s^{-1}$$
$$E_{xy} = 20.0 \ m^2 s^{-1}$$

The sensitivity of the model to these coefficients was not known. A single computer run was made with each of these values cut in half. The resultant change in velocities was only about 1-2%. The turbulent eddy viscosity coefficients are parameters that can be easily manipulated by the operator for the purpose of calibrating the model. Therefore, a more detailed study on the effects of making larger changes in these parameters may easily be undertaken if necessary.

4.1.2.3 Manning's n. The first set of computer runs was made with n = 0.045. This value was calculated in accordance with the method proposed by Christensen (1975) from a few scattered velocity profiles obtained in the field. From the velocity profiles that were logarithmic (surprisingly few of them were not), an average of the n values was taken. This average was input as a constant value for the entire bay.

Since the first set of runs yielded velocities that were too small, a second set of runs was made with n equal to a constant 0.030 throughout the bay. The result of this change will be discussed in more detail in the next section.

It is also possible to input varying values of Manning's n throughout the bay. Although this is more time consuming than simply supplying a constant value, it is the only way to account for differences in bottom friction at various locations. This type of input can be used as a final step in "fine-tuning" the model.

4.1.2.4 River Flow. Although river flow is a physical characteristic of the bay, the exact river discharges are not known for the periods during which data was taken. However, average monthly flows for the Apalachicola River (1961 - 1976) were available from the U.S.G.S. so these values were used (see Table 4.1 and Figure 1.7). Fortunately, errors in the river flow do not significantly affect the overall hydrodynamics of the bay, because the river flow constitutes a very small part of the total amount of water entering the bay. This is illustrated in the following calculation showing the ratio of river flow ($\overline{Q}$ = 705 m^3s^{-1} for the Apalachicola River) during a half tidal cycle to a mean tidal prism height of 0.5 m:

Table 4.1. Average Monthly Flows for the Apalachicola River for Period 1961-1976.

Month	Mean Discharge m^3s^{-1}	Ratio to Mean Annual Discharge
O	387	.55
N	391	.56
D	617	.88
J	985	1.40
F	1131	1.60
M	1209	1.72
A	1082	1.54
M	687	.97
J	580	.82
J	505	.71
A	496	.70
S	392	.56
Mean Annual Discharge	705	1.00

These values correspond to the hydrograph given in Figure 1.7.

$$(100\%) \cdot \frac{(705\ m^3 s^{-1})\ (60\ s\ min^{-1})\ (60\ min\ h^{-1})\ (6.21\ h)}{(550\ km^2)\ (0.5\ m)\ (1{,}000{,}000\ m^2\ km^{-2})} = 5.7\%$$

4.1.2.5 Wind Velocity. The model does not provide for the input of time-varying wind velocity, so average velocities were used. For the run used as a comparison with the internal water surface fluctuations:

wind velocity = 2.24 m s^{-1} (5 mph) at 207° clockwise from North

For the two runs used as comparisons with water velocities:

wind velocity = 2.24 m s^{-1} (5 mph) at 0° clockwise from North

4.1.2.6 Tide Information at Boundaries. The tidal curves at the boundaries are input to the model as a set of amplitudes and times. The model then approximates the tides as a series of sinusoidal curves. It is important that the first half tide curve input to the model is one of increasing water elevation (i.e., from low tide to high tide) since the initial depths in the model are at MLW.

Complete tidal information at all boundaries was available for the run used as a comparison with the internal water surface fluctuations. However, for the two runs used as comparisons with the water velocities, only partial boundary data was available. (Tide gages were only set-up at East Pass and Indian River Pass when the velocity data were gathered.) Correction factors for both amplitude and time lag were established from the complete set of curves and used to estimate the tidal curves at West Pass and Sikes Cut for the remaining runs from the information at East Pass.

4.1.2.7 Depths at MLW. The depths input at each node were obtained from a Navigational Chart published by NOAA. The depths input at West Pass and Sikes Cut are slightly lower than the actual values, because the latter causes instabilities in the model with the 60 second time step. Using a time step small enough to permit the input of actual depths would make the cost of running the model prohibitive. To compensate for the smaller depths, larger than actual widths were input so that the cross-sectional area of the outlets remained the same.

4.1.3 Comparison of Model Results with Field Data

Figures 4.7 and 4.8 show field measurements and model results for the water surface fluctuations at two points, B and A, in the bay. Computer results are shown for n = 0.045 and n = 0.030. At point B, both computer runs are extremely close to the range and phase lag of the actual curve. The change in Manning's n produced only about a 5 percent change in the tidal range and almost no difference in the phase lag. This is important to note, since the same change induced a much larger difference in velocities. The difference between the range of the computer run with n = 0.030 and the actual measured range is only about 7 percent.

At point A, there is almost exact correlation between the range of the n = 0.030 computer run and the range of the recorded curve. However, there appears to be a slight phase lag difference between the two (about 10 percent).

Similar correlations between measured and computed velocity and velocity orientation are obtained with the model. Figure 4.9 shows the comparison at point C as an example. Observed and computed values of the vertically averaged velocities at points A through B show similar satisfactory agreement. The predicted model velocities are often lower than the observed velocities. However, Wang (1978) reports that a comparison of current velocities measured by portable current

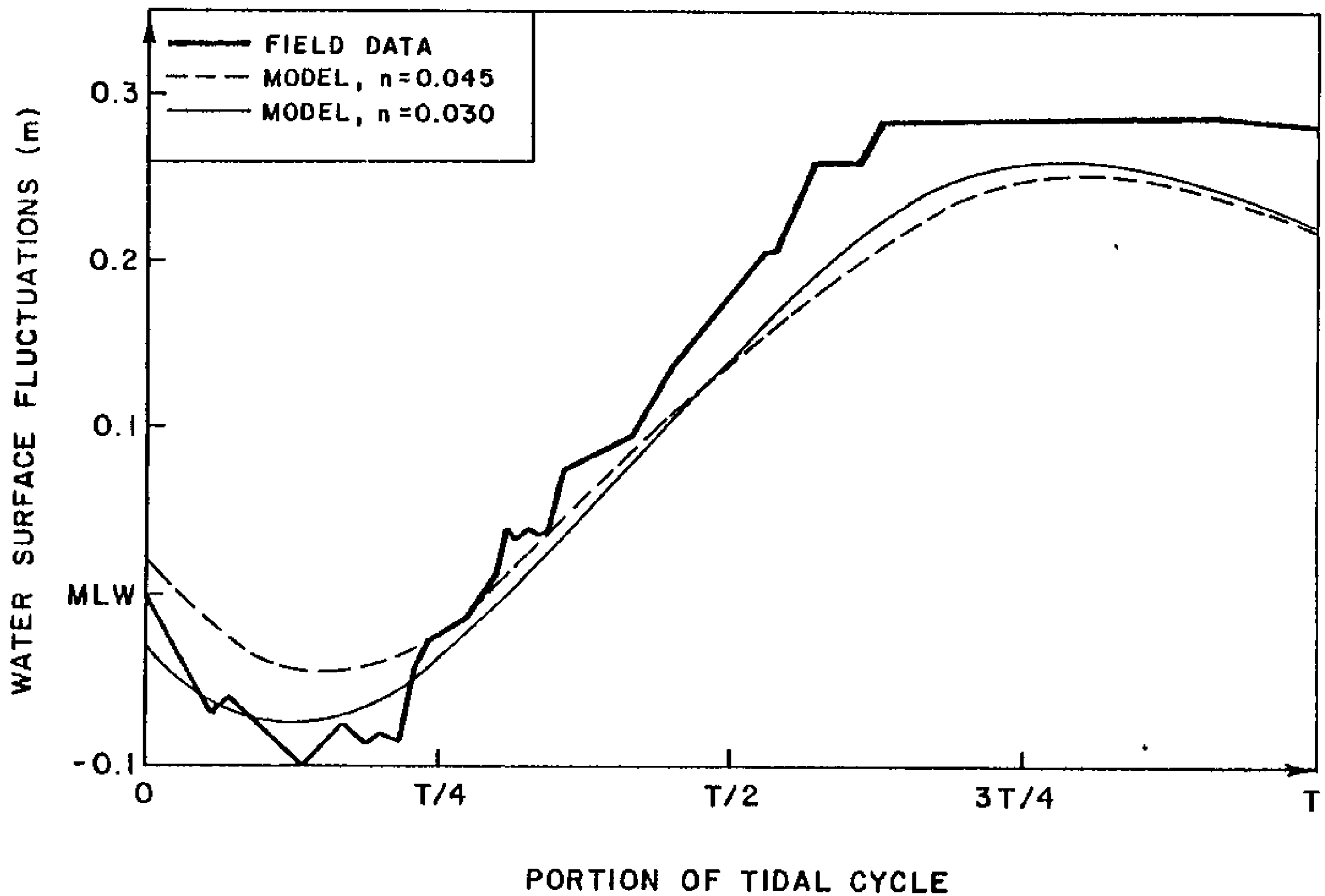


Figure 4.7. Water Surface Elevation vs Time at Point B in Apalachicola Bay.

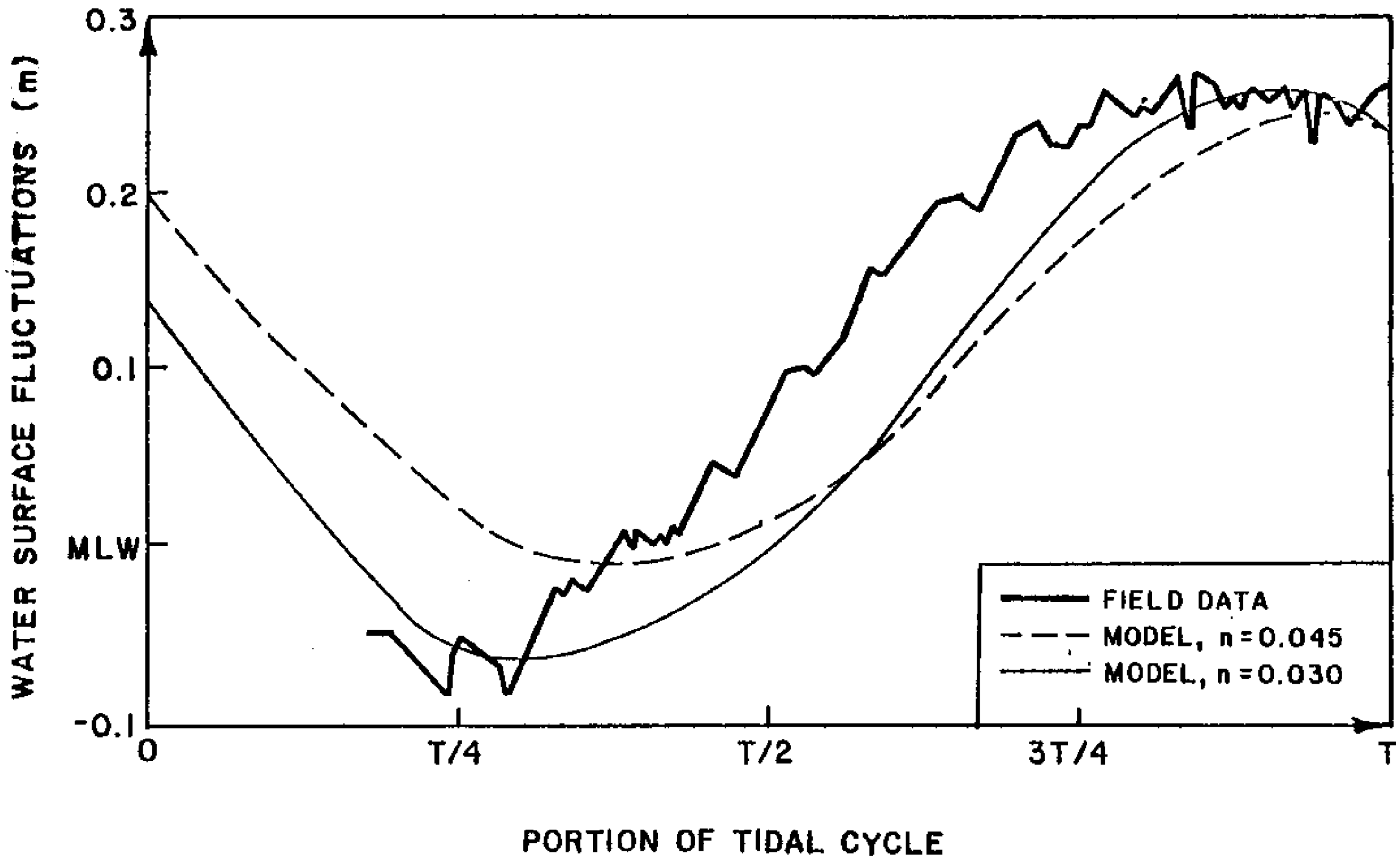


Figure 4.8. Water Surface Elevation vs Time at Point A in Apalachicola Bay.

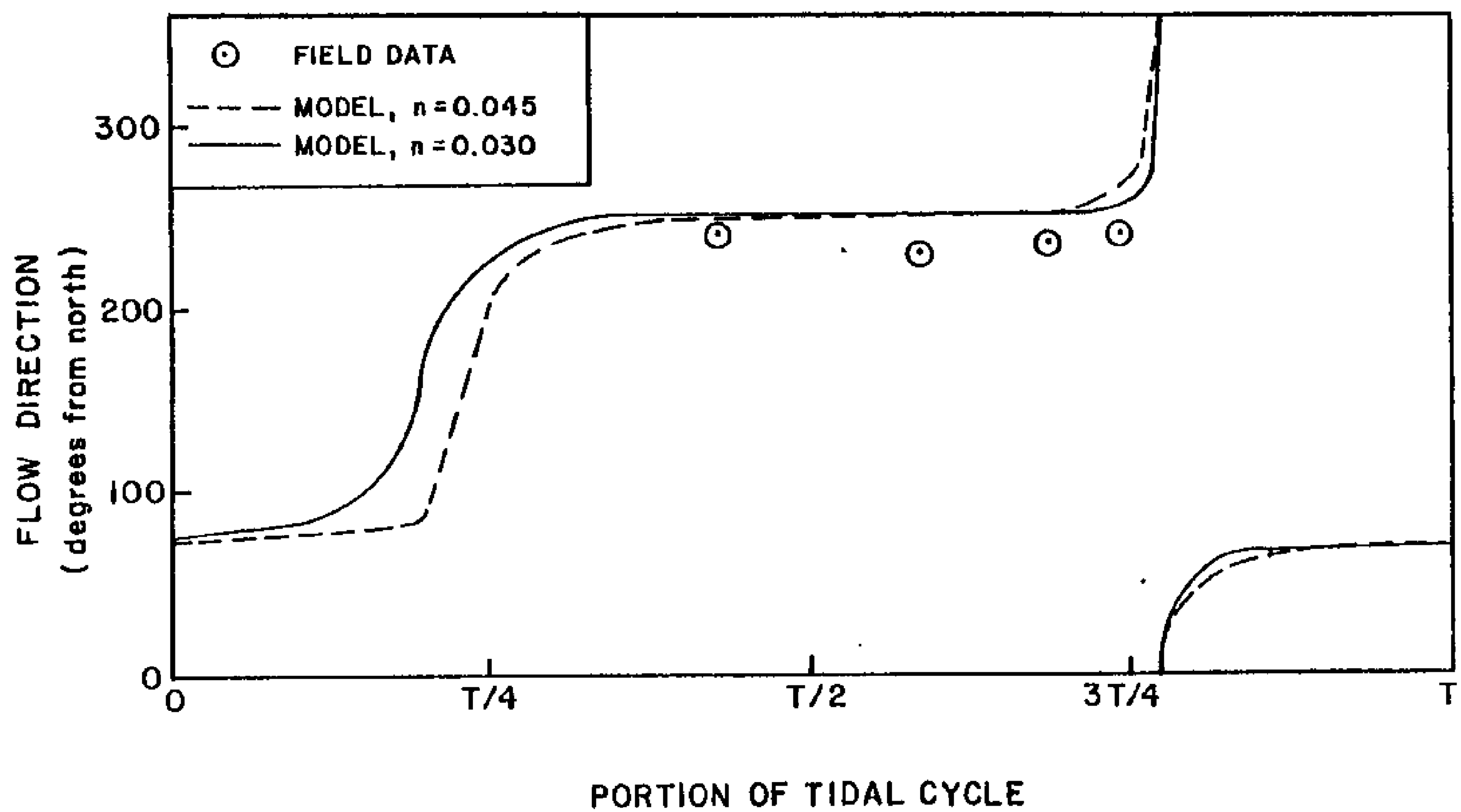


Figure 4.9. Comparison of Observed and Computed Velocity Direction as Function of Time at Point C.

meters from boats with those measured by recording current meters mounted on fixed structures showed that the former tend to be inflated due to wave motion. Hence, the agreement between observed and model predicted velocities may be even better than the observations indicate.

4.1.4 Comparison with Wang's Verification

Figures 4.10 and 4.11 show field and preliminary model results obtained by Wang (1978) using the CAFE-1 model at Biscayne Bay. Wang considers his results to be good for an initial computer run with no adjustments. All of the results for Apalachicola Bay discussed in the previous section fall well within the errors illustrated in the two figures. Therefore, it may be assumed that CAFE-1 correctly predicts the principal physical processes in Apalachicola Bay. However, further refinement is still possible as more detailed data in specific areas are obtained.

4.1.5 Further Calibration

Because of the large change in velocities occurring when n was decreased from 0.045 to 0.030, it was estimated that further decreasing n to 0.015 would cause the model to output velocities of magnitudes approximately equal to those measured in the field. However, use of n = 0.015 results stability problems, presumably because the larger velocities produced violated the stability criterion. Since the instabilities occurred early in the run (about halfway through the first tidal cycle), it is possible that the velocities causing the stability problems are produced only as a result of the "cold-start" (i.e., all initial velocities and water surface elevations set equal to zero). Assuming that the steady-state velocities are smaller in magnitude than these initial velocities, it may be possible to eliminate the instabilities by inputting initial

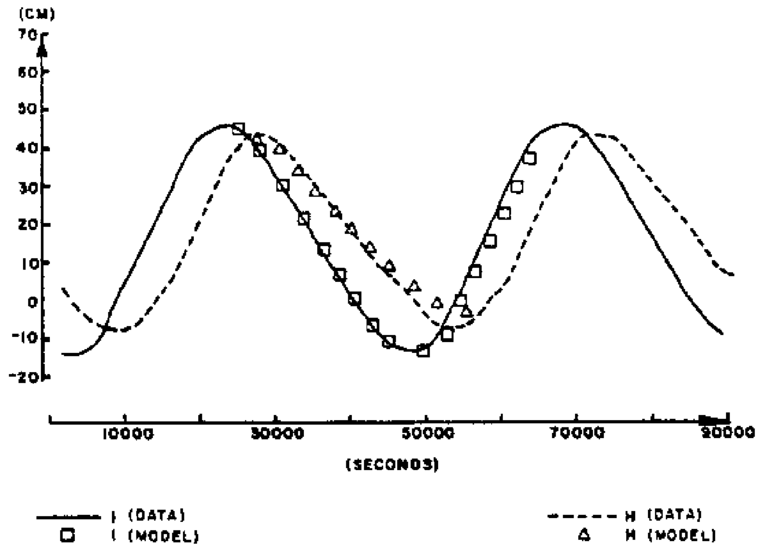


Figure 4.10. Surface Displacement Verification by Wang for a Model of Biscayne Bay Using CAFE-1 (Wang, 1978b).

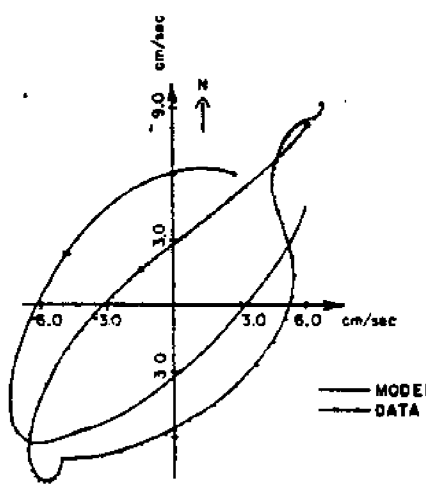


Figure 4.11. Hodograph Comparison by Wang for a Model of Biscayne Bay Using Cafe-1 (Wang, 1978b).

values for the velocities and water-surface elevations. These values can be estimated by using the model output from past runs. Although it will take some time to input these values initially, this change will probably decrease computer cost because less computer time will be required for the model to reach a steady-state. (The model is currently being run for three to five tidal cycles before the final information is output).

4.2 Verification of DISPER-1

The verification of a transport model can take many forms. Field data can be obtained for releases of a dye or other tracer from the river mouth or other sources. In an estuary of this size, the problems with such measurements can be simply too great in terms of time and manpower. A reasonable alternative is to model some naturally occurring substance which can be monitored by point samples through the bay, rather than following a tracer cloud. The best choice is salinity. While large amounts of salinity data exist on the bay, unfortunately concurrent tidal and velocity are data rarely available. Therefore, additional data was obtained for this study.

4.2.1 Field Data for Quality Verification

The specific set of salinity data to be treated here was taken in September, 1980, by a field crew from the Hydraulic Laboratory at the University of Florida and analyzed in Gainesville. The data are reported in Table 4.2.

A review of the data in Table 4.2 indicates both spatial and temporal variation of salinity; see, for example, the values at East Pass at two different times. Notice also some apparent small anomalies in the data which evidently reflect measurement error, symptomatic of difficulties of sampling in such an environment. It is also interesting that samples 22 to 26 at East Pass are inverted from that expected, indicating possible

Table 4.2. Salinities in Apalachicola Bay, September 1980. Observed by Hydraulic Laboratory, University of Florida.

Sample No.	Approximate Location	Salinity ppt	Date, Time of Sample
1	Apalachicola River Mouth	1.6^{s}	9-18-80, 1010
2	Apalachicola River Mouth	21.2	9-18-80, 1010
3	Center of Bay	30.4^{3}	9-18-80, 1100
4	Center of Bay	30.0	9-18-80, 1100
5	Center of Bay	31.6	9-18-80, 1100
6	Center of Bay	28.8	9-18-80, 1100
7	Center of Bay	31.2^{b}	9-18-80, 1100
8	West Pass	33.2^{s}	9-18-80, 1630
9	West Pass	34.0	9-18-80, 1630
10	West Pass	29.2	9-18-80, 1630
11	West Pass	33.8	9-18-80, 1630
12	West Pass	32.4^{b}	9-18-80, 1630
13	Sikes Cut	29.8^{s}	9-18-80, 1730
14	Sikes Cut	30.0	9-18-80, 1730
15	Sikes Cut	31.8	9-18-80, 1730
16	Sikes Cut	32.0	9-18-80, 1730
17	Sikes Cut	33.0^{b}	9-18-80, 1730
18	East Pass	35.0^{s}	9-19-80, 1140
19	East Pass	35.0	9-19-80, 1140
20	East Pass	34.4	9-19-80, 1140
21	East Pass	34.8^{b}	9-19-80, 1140
22	East Pass	36.8^{b}	9-26-80, 1500
23	East Pass	35.8	9-26-80, 1500
24	East Pass	38.2	9-26-80, 1500
25	East Pass	44.3	9-26-80, 1500
26	East Pass	43.5^{s}	9-26-80, 1500
27	New River	28.7	9-26-80, 1600
28	South Span-Causeway	34.9^{s}	9-26-80, 1820

s = surface
b = bottom

Table 4.2 - continued.

Sample No.	Approximate Location	Salinity ppt	Date, Time of Sample
29	South Span-Causeway	36.1	9-26-80, 1820
30	South Span-Causeway	35.0	9-26-80, 1820
31	South Span-Causeway	37.8	9-26-80, 1820
32	South Span-Causeway	35.5[b]	9-26-80, 1820
33	South Span-Causeway	37.5[s]	9-26-80, 1820
34	North Span	30.4[s]	9-27-80, 1150
35	North Span	34.4	9-27-80, 1150
36	North Span	34.8[b]	9-27-80, 1150
37	St. George Sound	38.4[s]	9-27-80, 1300
38	St. George Sound	37.4	9-27-80, 1300
39	St. George Sound	37.8	9-27-80, 1300
40	St. George Sound	38.6	9-27-80, 1300
41	St. George Sound	41.1[b]	9-27-80, 1300
42	St. Vincent Sound	25.0[s]	9-28-80, 1200
43	St. Vincent Sound	22.6	9-28-80, 1200
44	St. Vincent Sound	24.1[b]	9-28-80, 1200

s = surface
b = bottom

upwelling or local disturbances. This sort of variability should be recalled when assessing model agreement with the data. It should further be noted that the model, being two-dimensional, yields a depth-averaged concentration value.

4.2.2 Model Input for Verification Runs

Due to the time span in salinity measurements, typical tides and winds for that period were specified for a CAFE run to form hydrodynamic input to DISPER. While this of course may lead to some inadequacies in the simulation, it was perceived as a good test, for uncertainity in these model parameters often exists. The 439 element, 281 node general grid shown in Figure 3.1 was used again for the simulation. Salinities of 36 ppt were specified at the external passes and inlets, with 10 ppt and 5 ppt at appropriate elements for the river mouth. River flow was taken at 337 m^3s^{-1} during this period, based on USGS records.

Some oscillations of concentrations were observed in the early simulation. As noted earlier, both the spatial increment, Δx, and the time increment, Δt, bear on this problem. Changing Δx means a change in the grid, locating critical areas and then refining the grid there.

Oscillations in the results caused some experimentation with the dispersion coefficient, D_{ii}, resulting in specifying input values which typically yield maximum values of D_{ii} of 150-300 m^2s^{-1} in the bay.

These values are within the range of reported values for estuaries. Further accuracy considerations resulted in selection of a time step, Δt, of 60 seconds. These steps were chosen first in the verification process as they represent reasonable options for the typical user.

4.2.3 Results of DISPER-1 Verification Runs

Results of one verification run are shown in Figure 4.12. Values shown in the elements are salinities in parts per thousand. It can be seen by comparison with Table 4.2 that there is reasonable agreement with measured values in the East and West Pass regions, in St. Vincent Sound, and in the East Bay - East Point region where the freshwater input from the Apalachicola River is so important. There are, however, some regions where values are too low, especially near the causeway island and slightly east of that region.

There are several possible explanations for these low values in the regions noted. First, it should be observed that the figures shows a synoptic view of the bay, i.e., at a single time, while the observations in Table 4.2 were taken over a range of times and therefore occur at different parts of the tidal cycle. What is more important, however, is the fact that measurements spanned such a long time that varying wind, tides, and other conditions can significantly influence bay behavior. The run pictured here is based on a constant wind speed and direction. In addition, no attempts have been made to fine-tune CAFE results by varying Manning's n across the bay and other such steps which might help resolve some localized errors.

It appears that verification is easier against data taken synoptically, such as in enhanced LANDSAT photographs. Comparison of predicted and observed shapes and extents of plumes, i.e., pattern recognition, can provide a good assessment of model performance. Graham, Hill and Christensen (1978) and Hill and Graham (1980) reported on use of such data for this verification.

In conclusion, it can be stated that an attempt at model verification with no fine-tuning yielded acceptable results over much of the bay.

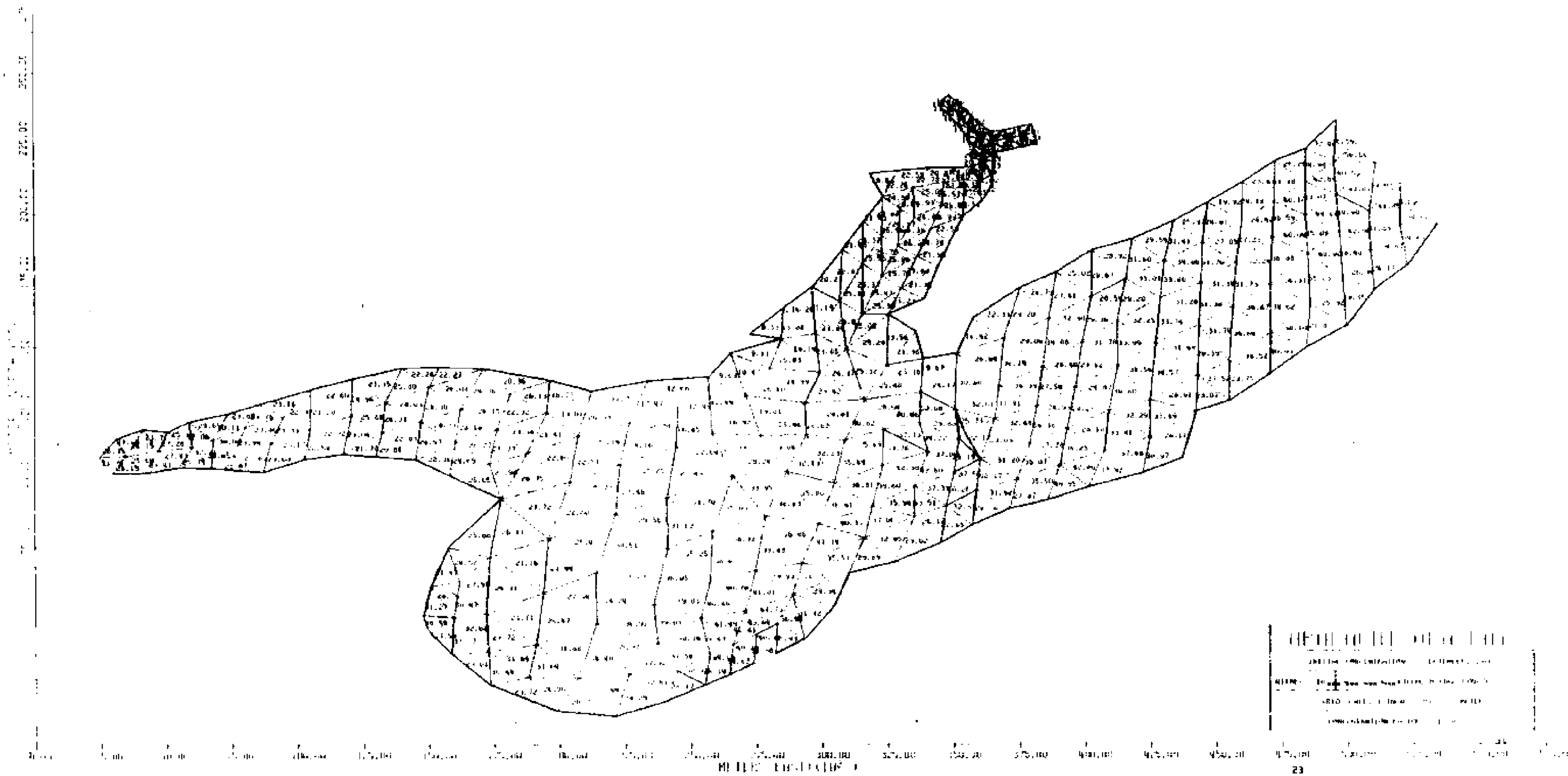


Figure 4.12. Salinity Run for Apalachicola Bay Using DISPER-1.

However, some changes in element arrangement would be necessary to remove some locally low values near the causeway island.

4.3 Satellite Verification of DISPER-1

Use of LANDSAT imagery computer enhanced for surface water color may be utilized for verification of the DISPER-1 model, since surface water color and water quality (e.g., acidity expressed by pH) may be related. Since the satellite images only reveal what is going on in the upper inches of the water column, it may be difficult to let the images relate to the vertically averaged water quality. However, the general pattern of the dispersion of a pollutant at the surface may be observed and compared to the print-out of the DISPER-1 model. Assuming a well-mixed bay, the surface water quality should indeed be indicative of the vertically average quality parameter.

Verification by such pattern recognition from LANDSAT images has given surprisingly good results.

Figure 4.13 shows an example of the color enhanced pictures used. Note the red colored water in East Bay and at Carrabelle. This color indicates low pH water. The pattern shown in Figure 4.13 is in almost perfect agreement with computer printouts. The plume at Sikes Cut is also noteworthy. Also this phenomenon may be reproduced by the model.

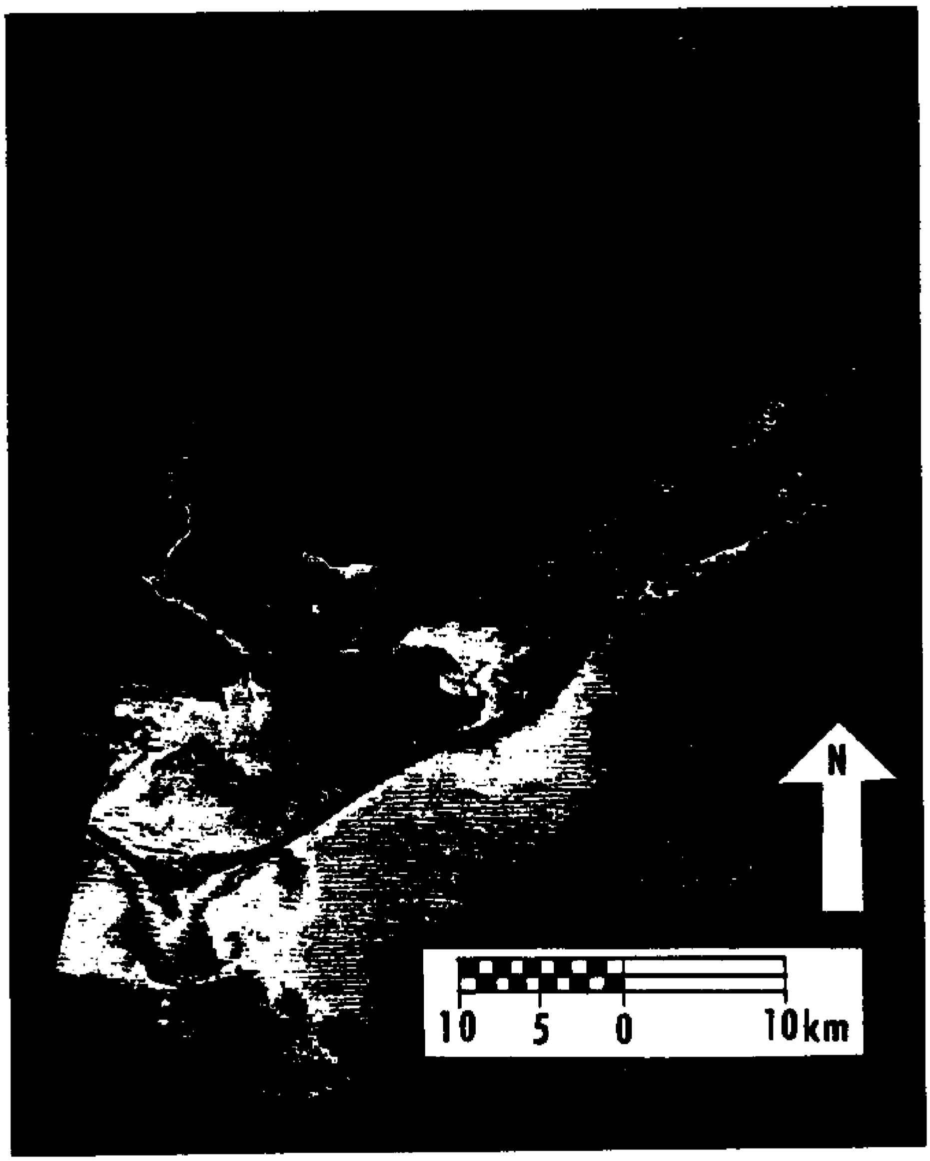


Figure 4.13. Computer Enhanced LANDSAT Image Showing Water Quality Patterns in Apalachicola Bay.

5. THE ATLAS. SELECTION OF CONDITIONS FOR A TYPICAL YEAR

To illustrate more clearly behavior in the bay, model solutions demonstrating variation through a typical year were sought. The objective is to provide an overview of possible behavior, with the expectation that specific problems will still require running the model for conditions appropriate to those problems. The material generated for the average year is presented in the form of an atlas at the end of this report.

There are several sets of physical parameters to be selected to provide a view of bay behavior. Major ones include the following:

1) Tides - amplitude and phase lag.
2) River flows.
3) Wind speed and direction.
4) Source location and loading.

To provide a reasonable view of expected bay behavior and yet keep the size of this report reasonable, it was decided to produce runs for each month, or twelve in all. Therefore, parameter values selected should be expected to represent monthly average values.

5.1 River Flows

The average monthly river flows shown in Table 4.1 were used for the CAFE-1 simulations.

5.2 Tides

Tidal data was obtained from the National Ocean Survey for the five-year period from 1975-1980. Tide tables and the tidal data discussed in Section 4.1.1.1 were used to estimate expected tidal height variations from points of measured values to other boundary points and time (phase) lag between tidal peaks.

The tide at Apalachicola is considered diurnal, in that two highs or two lows may occur on the same day with different amplitudes. This is clearly indicated in Figure 4.3. There are difficulties and uncertainities associated with selecting a "typical" tide pattern for each month of the form in Figure 4.3. In addition, the runs of interest, and many problems of practical interest, occur over several tidal cycles. This tends to average out the influence of tidal amplitude variation. Therefore, given the objective of providing an overview of bay behavior, it was decided to simply use mean tidal amplitudes to drive the model, with a respecting sinusoidal tide specified. This should reproduce the general structure well, although there may be small local differences at individual times within a tidal cycle.

A review of the tidal data from 1975-1980 showed mean tidal ranges at the Apalachicola gage rather close to one foot for all months. The lowest value obtained was 0.86 ft and the highest 1.10 ft. No consistent trend appeared by month, at least for the five years reviewed. It was therefore decided to simply use a single value of 1.0 ft (or a tidal amplitude of 0.50 ft = 0.155 m). Review of tide tables and UF measured data then led to the tides at the bay boundaries, as shown in Table 5.1.

Table 5.1. Tidal Amplitudes and Phase Lags for Model Runs.

Location	Tidal amplitude, m	Phase lag, s
East Pass	0.23	0
Sikes Cut	0.19	2520
West Pass	0.13	3780
Indian Pass	0.10	5400

Again, these values are taken as typical and should not be interpreted as representing any specific case.

5.3 Winds

Wind is an extremely important factor in bay behavior. Wind data from 1975 through early 1981 was obtained from the Apalachicola office of the National Weather Service in the form of monthly summaries of Local Climatological Data, with wind speed and direction reported at three-hour intervals, as well as daily and monthly average speeds and directions. A review of the data led to selection of the montly average wind values shown in Table 5.2.

Table 5.2. Monthly Average Values of Wind Speed and Direction Used in Model Runs.

Location	Wind Speed, mi/hr	Wind direction, deg. from N[a]
January	8.4	030
February	8.2	073
March	8.4	186
April	7.9	192
May	7.4	182
June	7.0	197
July	6.3	217
August	6.1	130
September	6.7	110
October	7.15	063
November	7.3	078
December	7.4	045

a: For example, 090 is a wind from the East, 180 from the South, etc.

Variation in wind speed shown in Table 5.2 seems less significant than direction. Note the tendency of the wind to be from slightly west of south during March-July, but more like easterly to northeasterly during the rest of the year.

5.4 Generated Results

The model CAFE-1 is run with the grid shown in Figure 4.7 for each of the twelve months, utilizing river flows from Table 4.1, tidal information from Table 5.1 (the same for all months), and the wind data from Table 5.2. The results will be presented as views of the velocity field throughout a tidal cycle and the net velocity field over a cycle. Output from CAFE-1 runs for each of the twelve months will then be used to drive a DISPER-1 run representing a continuous discharge concentration of 100 units (ppm, eg.) in the river water.

The results from the conservative pollutant can be scaled directly to salinity by assuming an average salinity at the river mouth of 7.5 ppt (typical) with 36 ppt at the ocean boundary. Then any reported concentration can be converted to salinity by

$$s = 36 - 0.285\ c \tag{5.1}$$

in which c = concentration projected by model

s = salinity in ppt

Full results are presented in the attached Atlas in 204 maps depicting hydrodynamics as well as water quality during the "average" year.

6. DETERMINATION OF POLLUTANT CONCENTRATION (AND SALINITY) AT AN ARBITRARY LOCATION FOR OTHER RIVER CONCENTRATIONS AND OCEAN CONCENTRATIONS

The computer prepared maps, given in the atlas showing the distribution of conservative pollutant concentrations c in the Apalachicola Bay, are based on the river concentration $c_R = 100$ (e.g., ppm) and the ocean (Gulf of Mexico) concentration $c_o = 0$.

Pollutant concentrations, c_1, corresponding to other river and ocean concentrations may be found from these maps by use of a simple conversion formula to be established in the following.

Since the c distribution, shown in the maps and schematically in the upper part of Figure 6.1, is a solution to the differential equations governing the migration of conservative pollutants in the Apalachicola Bay, it is easily proven that the concentration c_1 given by the linear expression

$$c_1 = a\,c + b \tag{6.1}$$

also must be a solution. In Equation (6.1) a and b are constants.

A special case of Equation (6.1) is

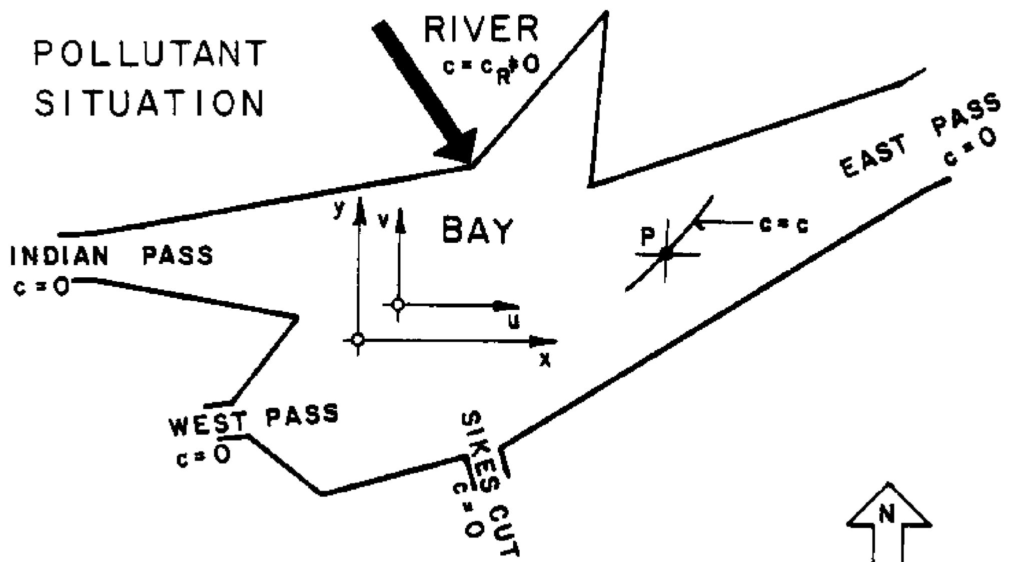
$$c_1 = c\,\frac{c_R - c_o}{100} + c_o \tag{6.2}$$

in which c_R and c_o are arbitrary pollutant concentrations in the river and ocean, respectively.

This equation satisfies the boundary conditions

$c_1 = c$ for $c_R = 100$ and $c_o = 0$ corresponding

to the original c-mapping,



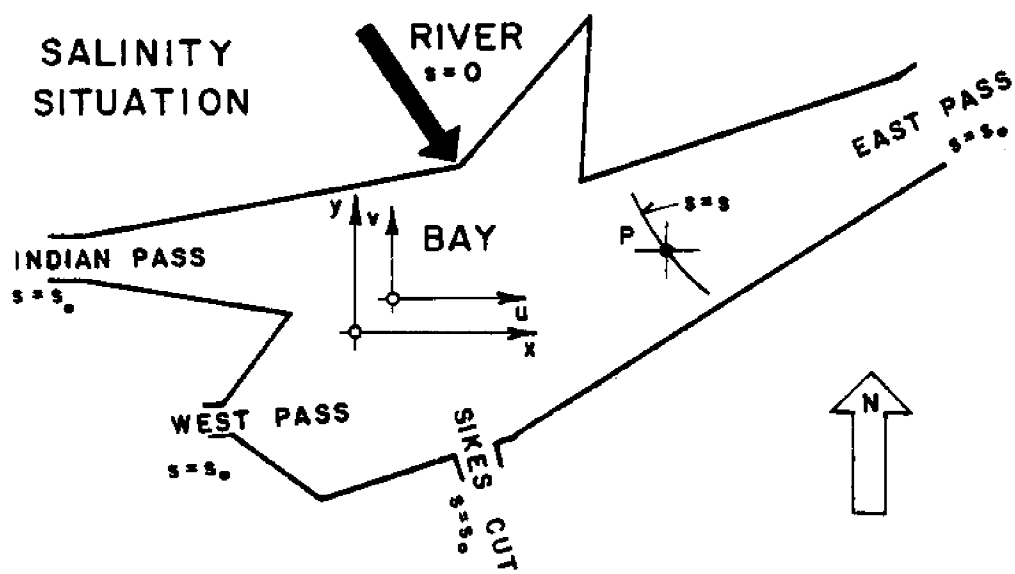


Figure 6.1. Schematic Maps Showing Boundary Conditions Used in Concentration Conversion Formulas.

$$c_1 = c_o \text{ for } c = 0$$

$$c_1 = c_o \text{ for } c_R = c_o$$

and $$c_1 = c_R \text{ for } c_o = 100$$

Equation (6.2) will therefore give the pollutant concentration at any point where c, based on $c_R = 100$ and $c_o = 0$, is known when the river and ocean pollutant levels are known. The maps presented in the attached atlas will therefore, when combined with Equation (6.2), yield the vertical average of the pollutant concentration at any location in the bay and at any time during the tidal cycle for any values of c_R and c_o.

In the same way the maps may be used to predict the salinity at any point and at any time during the average tidal cycle.

The equation

$$s = (1 - \frac{c}{100})\, s_o \tag{6.3}$$

in which s = the salinity at (x,y) at time t and s_o = salinity of the Gulf of Mexico waters is of the same form as Equation (6.1). s is therefore a solution to the equations governing the water quality of the bay. Since it furthermore satisfies the boundary conditions

$$s = 0 \text{ for } c = 100$$

and $$s = s_o \text{ for } c = 0$$

it must represent the bay's salinity distribution. These boundary conditions are indicated in the lower part of Figure 6.1.

7. ACKNOWLEDGEMENTS

The work presented in this report is a result of numerical modeling research being performed by the University of Florida's Hydraulic Laboratory, sponsored by the National Oceanic and Atmospheric Administration, Office of Sea Grant, Department of Commerce, under Grant #NA80AA-D-00038, Project #R/EM-13, and by the Engineering and Industrial Experiment Station of the University of Florida. Support from the U.S. Army Corps of Engineers, Mobile District, is also acknowledged.

8. LIST OF SYMBOLS

The symbols used in this report are defined where they first appear in the text and in the following list of symbols.

a = dimensionless constant

b = dimensionless constant

c = vertically averaged pollutant concentration at point (x,y), at time t corresponding to $c_R = 100$. Note in Secton 3 c stands for the vertically integrated concentration while the vertically averaged concentration there is denoted $\overline{c}$

c_1 = vertically averaged pollutant concentration at point (x,y) at time t corresponding to $c_R \neq 100$

c_o = vertically averaged pollutant concentration in Gulf of Mexico and entrances to the bay

c_R = pollutant concentration of river water entering the bay

C_f = dimensionless friction coefficient

D = average estuary depth

D_{ii} = dispersion coefficient

D_{xx}, D_{xy}, D_{yy} = dispersion coefficients

E^*_{ii} = dimensionless turbulent eddy viscosity coefficients

E_{ij} = turbulent eddy viscosity coefficients

f = Coriolis parameter

F_{xx}, F_{xy}, F_{yy} = internal specific stress terms (stress/density)

$g = 9.806 \text{ m s}^{-2}$ = acceleration due to gravity

h = water depth below mean low water (MLW) at point (x,y)

$H = h + \eta$ = total depth at point (x,y) at time t

H_o = refer to grid location giving critical Δt - value

k = Nikuradse's equivalent sand roughness

L = estuary length

M_x, M_y = momentum addition per unit horizontal area

n = Manning's n = $k^{1/6}/(8.25\sqrt{g})$ (metric)

p = pressure

p^b = pressure at the bottom

p^s = pressure at the water surface

P = tidal prism

P_o = sources and sinks of mass

q_x, q_y = discharge per unit width in x- and y-direction, respectively

q_I = volume addition rate

Q = river discharge

R = tidal range

s = salinity at point (x,y) at time t

s_o = salinity in Gulf of Mexico at entrances to the bay

t = time

T = tidal period = 12.42 hr

$\hat{u}$ = expected velocity

(u,v) = vertically averaged velocity components in the x- and y-direction, respectively, at point (x,y) at time t

U_{10} = air velocity at 10 m above the water surface in m s^{-1}

x,y = horizontal Cartesian coordinates

z = vertical coordinate

Greek Letters

α = dimensionless coefficient

$\Delta \ell$ = characteristic grid length

Δt = time increment

Δx_o = refer to grid location giving critical Δt - value

η = elevation of water surface above mean low water (MLW)

$\hat{\eta}$ = expected tidal range

ρ = density of water

ρ_{air} = density of air

ρ_o = reference value of ρ

ρ_1, ρ_2 = characteristic extreme densities

τ^b = bottom shear stress

τ^s = surface shear stress

ω_{earth} = angular velocity of earth = $2\pi/(24 \cdot 3600)$

9. REFERENCES

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APPENDIX A

A HYDRODYNAMIC AND WATER QUALITY ATLAS of *THE APALACHICOLA BAY SYSTEM* Franklin County, Florida

Prepared Under
Sea Grant

Contract No. R/EM-13

by

Hydraulic Laboratory
Department of Civil Engineering
University of Florida
Gainesville, Florida

December 1981

FOREWORD

This somewhat unconventional atlas is intended to give the reader detailed information about velocity conditions, pollutant concentrations and salinity in the Apalachicola Bay System during an average year taking typical astronomical tides, wind intensities and river flow into consideration.

It covers the entire bay from Dog Island and East Pass in the East to St. Vincent Island and West Pass in the West and is based on the CAFE and DISPER finite element models applied to a grid system consisting of 489 elements and 281 nodes representing this bay area. The models have been verified by direct observations of salinities and velocities in the bay and by pattern recognition in LANDSAT pictures computer enhanced to show ocean and bay water quality by colors.

The Apalachicola Bay may be classified as a tide dominated well mixed estuarine system with only sporadic and unsignificantly small areas of stratification. Consequently, the river flow is of minor importance to the hydrodynamics of the bay. A hydrograph representing the monthly discharges averaged from 1971 to 1976 has therefore been used in the model to represent rates of freshwater flow into the bay.

While the river discharge is of minor importance to the hydrodynamics of the bay the same can not be said for pollutants brought into the bay by the river. This influence must be and is modeled in detail and the results are presented in such a way that the influence of any numerical value of the river water's pollutant concentration may be evaluated at any location in the system. As represented in this atlas the water quality predictions are limited to conservative pollutants, however, the numerical model may be extended to consider nonconservative substances transported by the water.

The atlas shows conditions during a typical tidal cycle representing each of the twelve months of the year. Each month's events are shown on seventeen individual sheets. The first eight show the distribution of the vertically averaged water velocities and their circulation during that tidal cycle in eight time increments of equal lengths beginning at low tide. These eight sheets are marked by the name of the month and number 1 through 8.

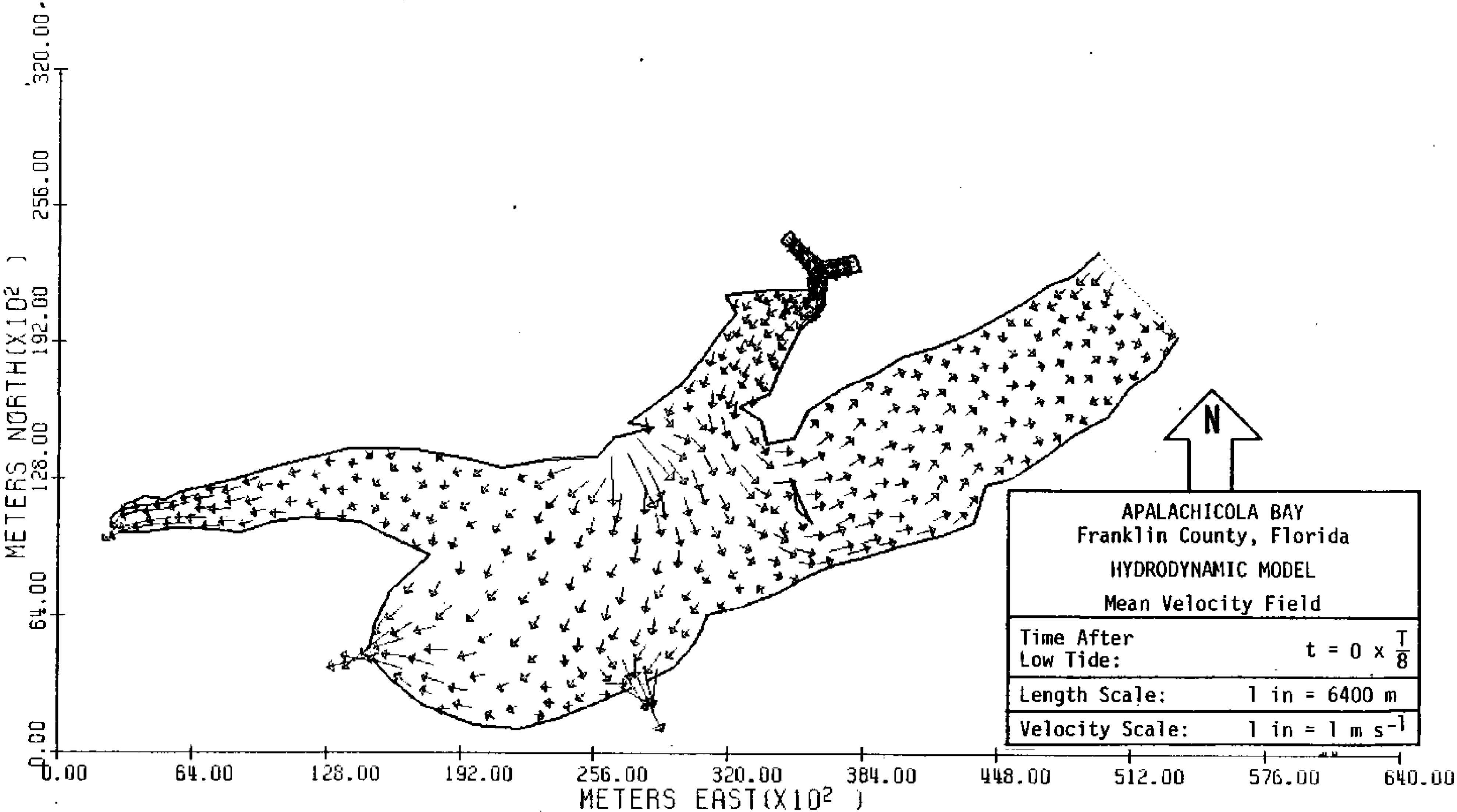
The ninth sheet, marked by name of the month and 9, represents the velocities from the first eight sheets averaged over the tidal cycle. In other words this is the net vertically averaged water velocity.

The remaining eight sheets, marked by the name of the month and numbers 10 through 17, are reserved for water quality. They show the distribution of the vertically averaged pollutant concentration c at the same times during the tidal cycle the vertically averaged horizontal velocities are given in sheets No. 1 through 8. The shown concentrations c are based on a concentration c_R of the same pollutant in the river discharge equal to 100 (e.g., ppm) and $c_o = 0$ pollutant concentration at all inlets to the bay from the Mexican Gulf. Simple formulas for the calculation of c-values corresponding to other c_R- and c_o-values and for determination of the vertically averaged salinity s from the salinity s_o at the inlets to the bay are given on the individual water quality sheets.

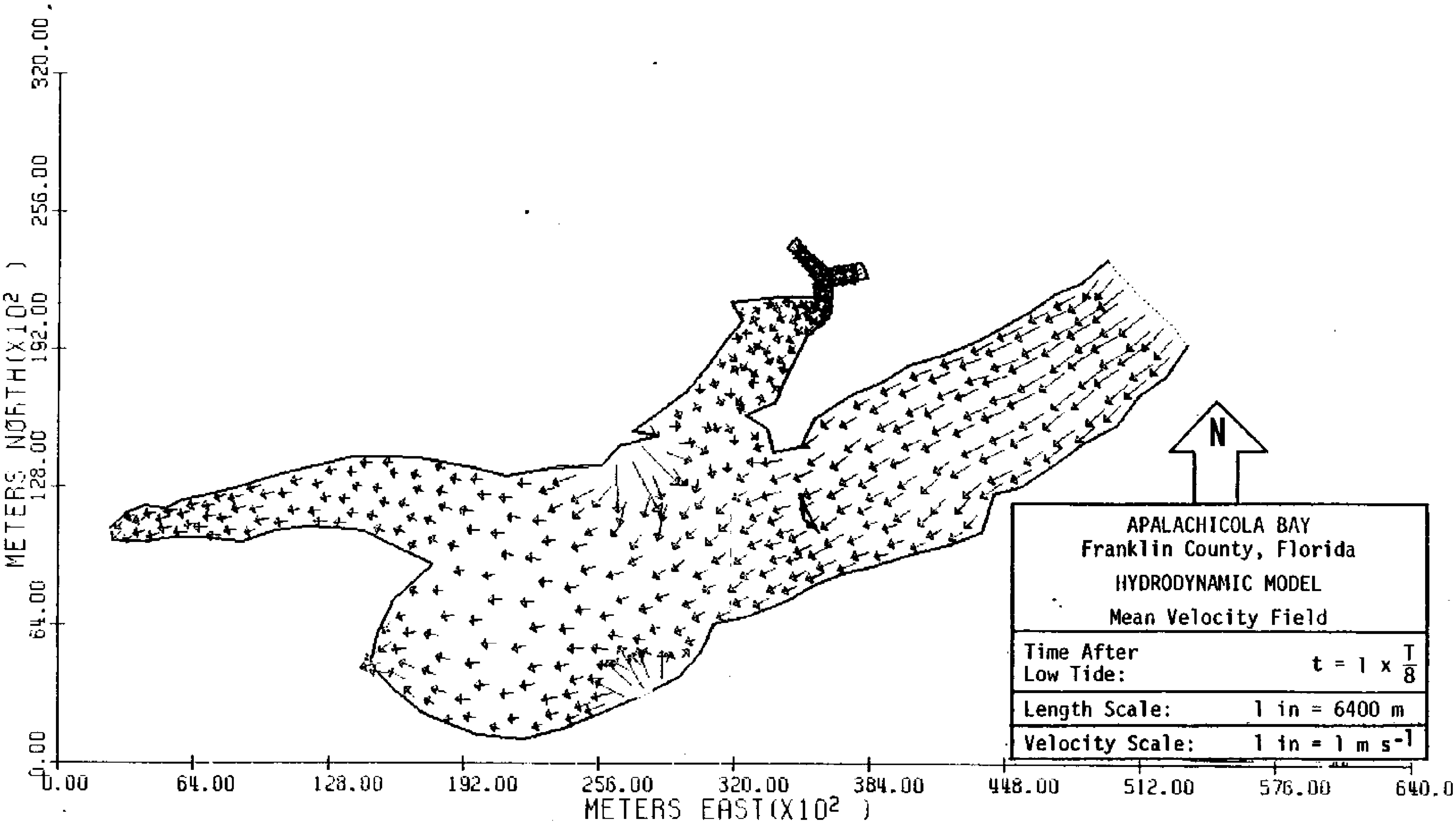
While this atlas will answer most questions concerning velocities, their orientation, pollutant concentrations and salinities it is limited inasmuch as it is prepared for average conditions during the year. Data corresponding to extreme conditions such as tropical storms or periodic excessive pollutant loads must be generated separately by use of the detailed computer model. This model is stored on tape and attached to this report.

JANUARY

JAN 1 through JAN 8:	Vertically averaged velocities v_m given at time increments equal to one eighth of the tidal period beginning at low tide.
JAN 9:	Net values of vertically averaged velocities. Time averaged over one tidal cycle.
JAN 10 through JAN 17:	Vertically averaged pollutant concentration corresponding to river concentration $c_R = 100$ and concentration $c_o = 0$ at all inlets to bay. Concentrations given at time increments equal to one eighth of the tidal period beginning at low tide.

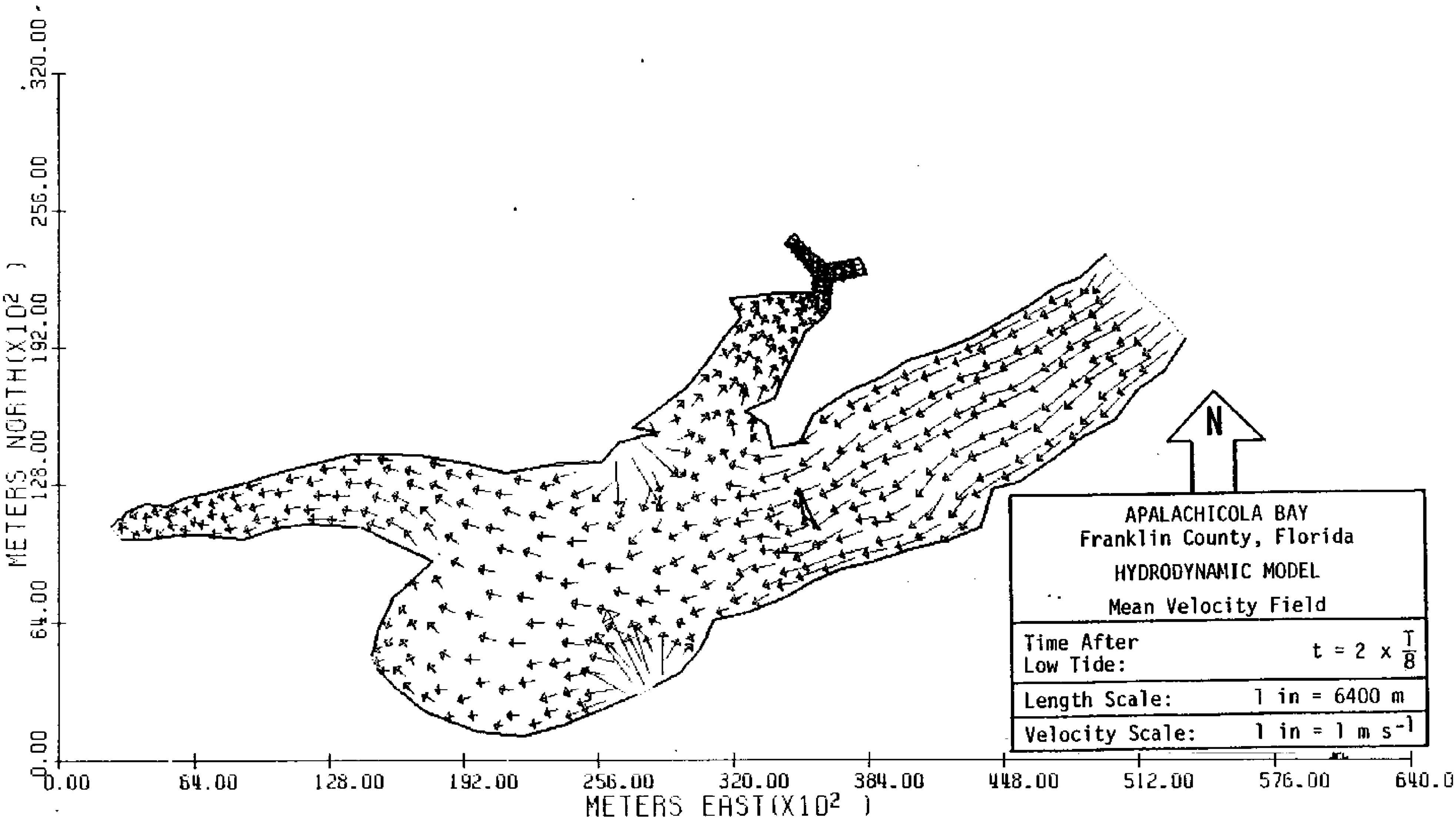

APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 0 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH($X10^2$)
METERS EAST($X10^2$)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

JAN 1

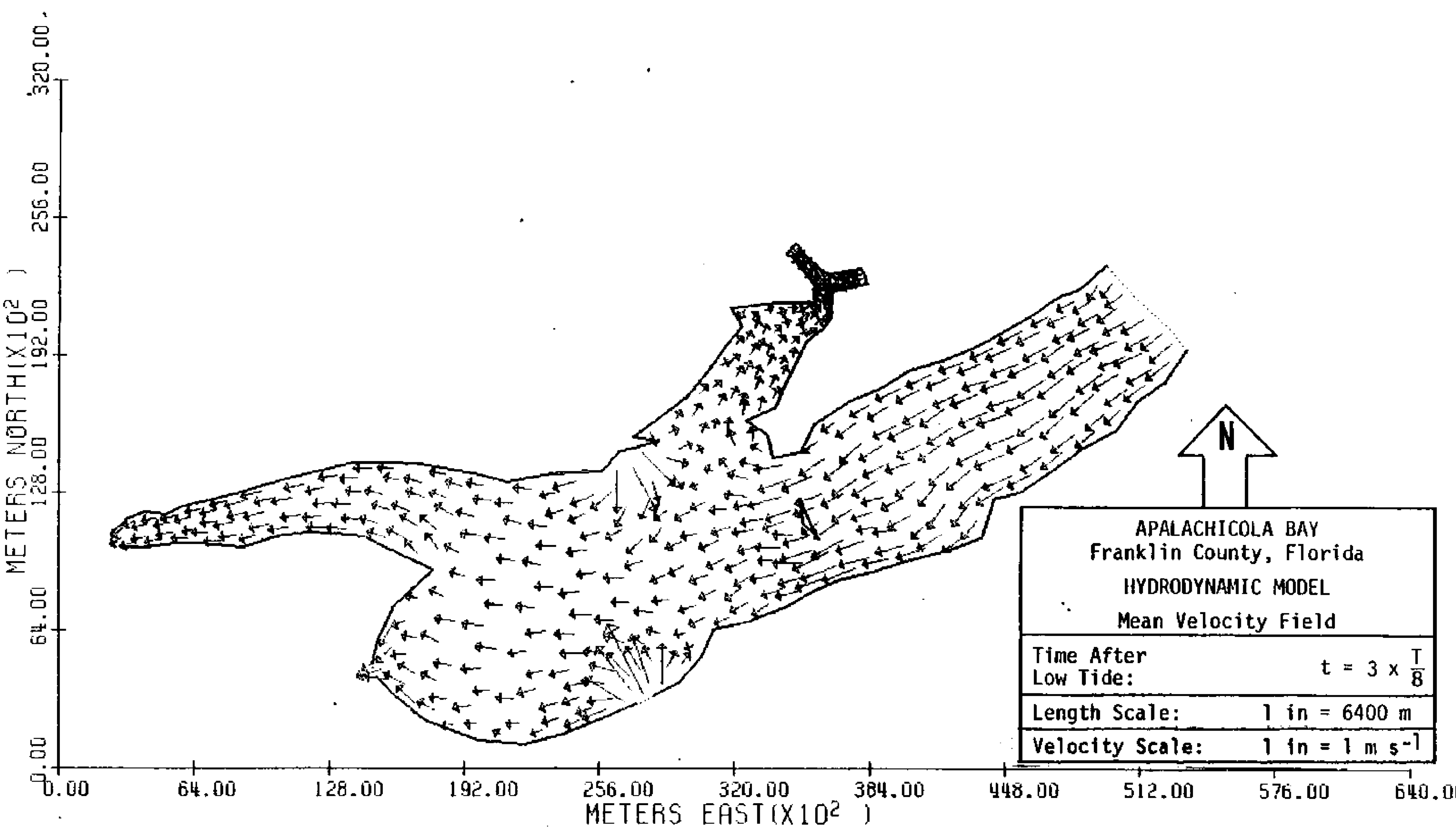


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 1 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

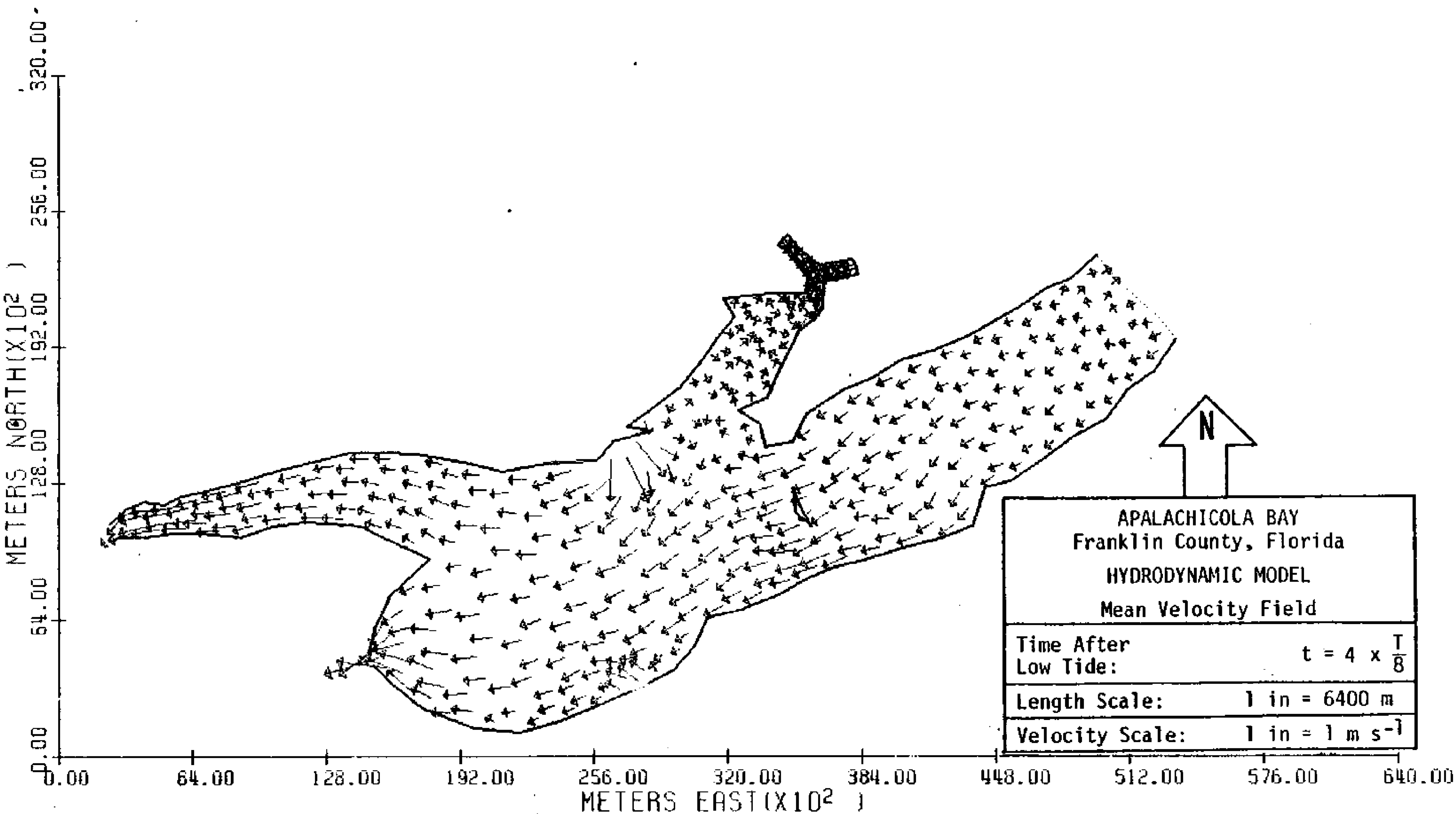
JAN 2


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 2 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

JAN 3

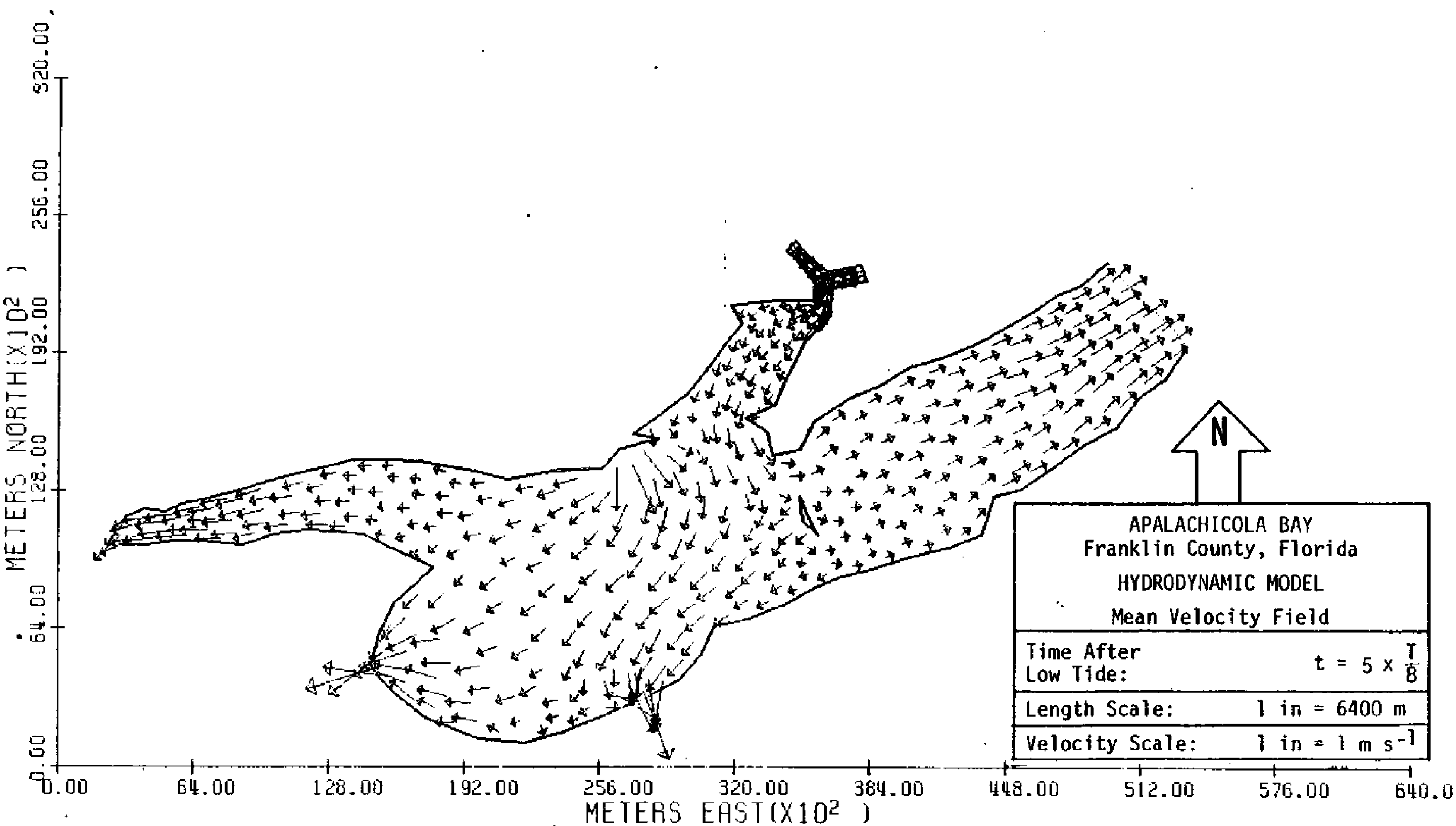

APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 3 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

JAN 4



APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 4 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

JAN 5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Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 5 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
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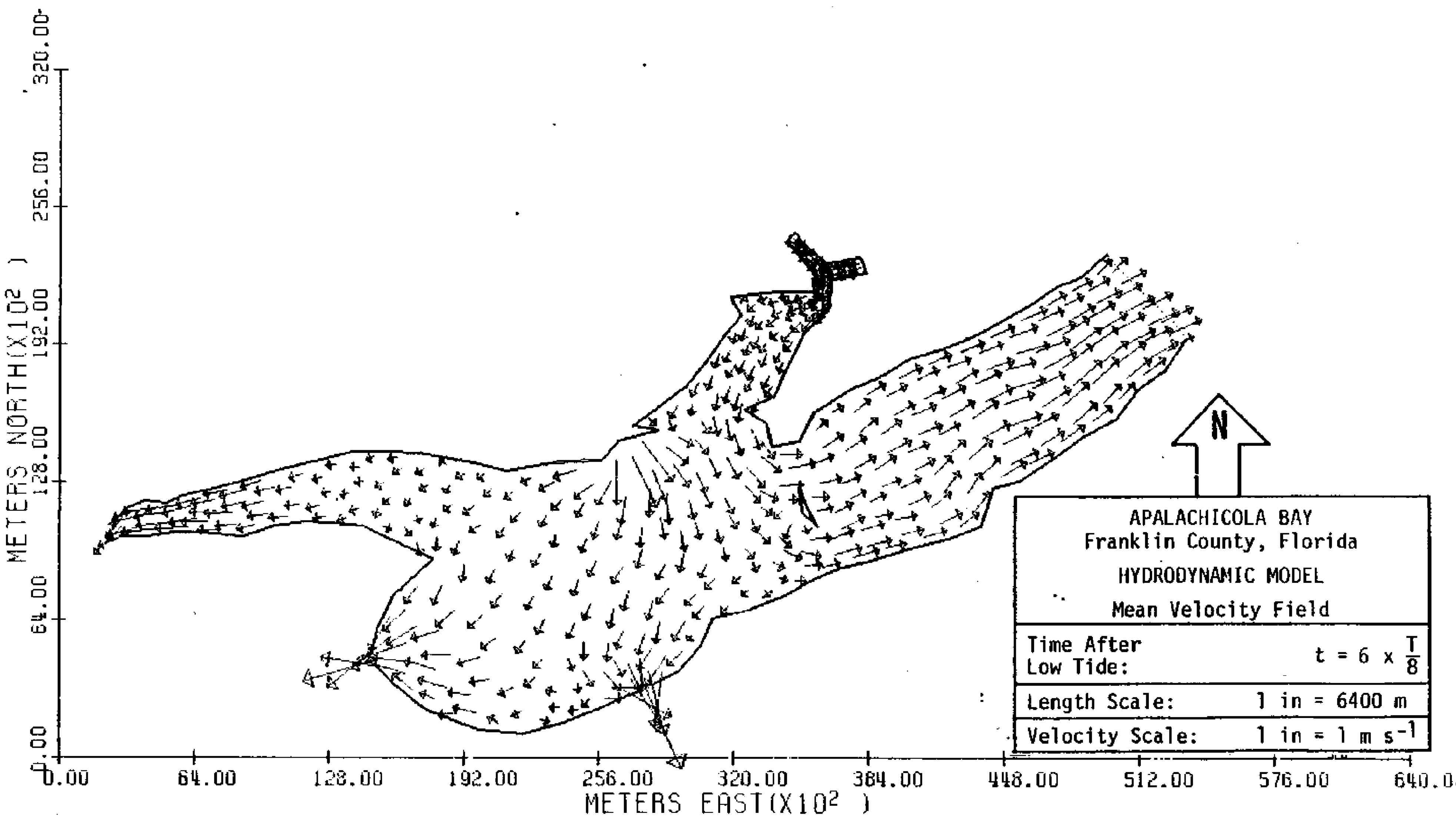
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00
920.00

JAN 6


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 6 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH($X10^2$)
METERS EAST($X10^2$)
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128.00
192.00
256.00
320.00
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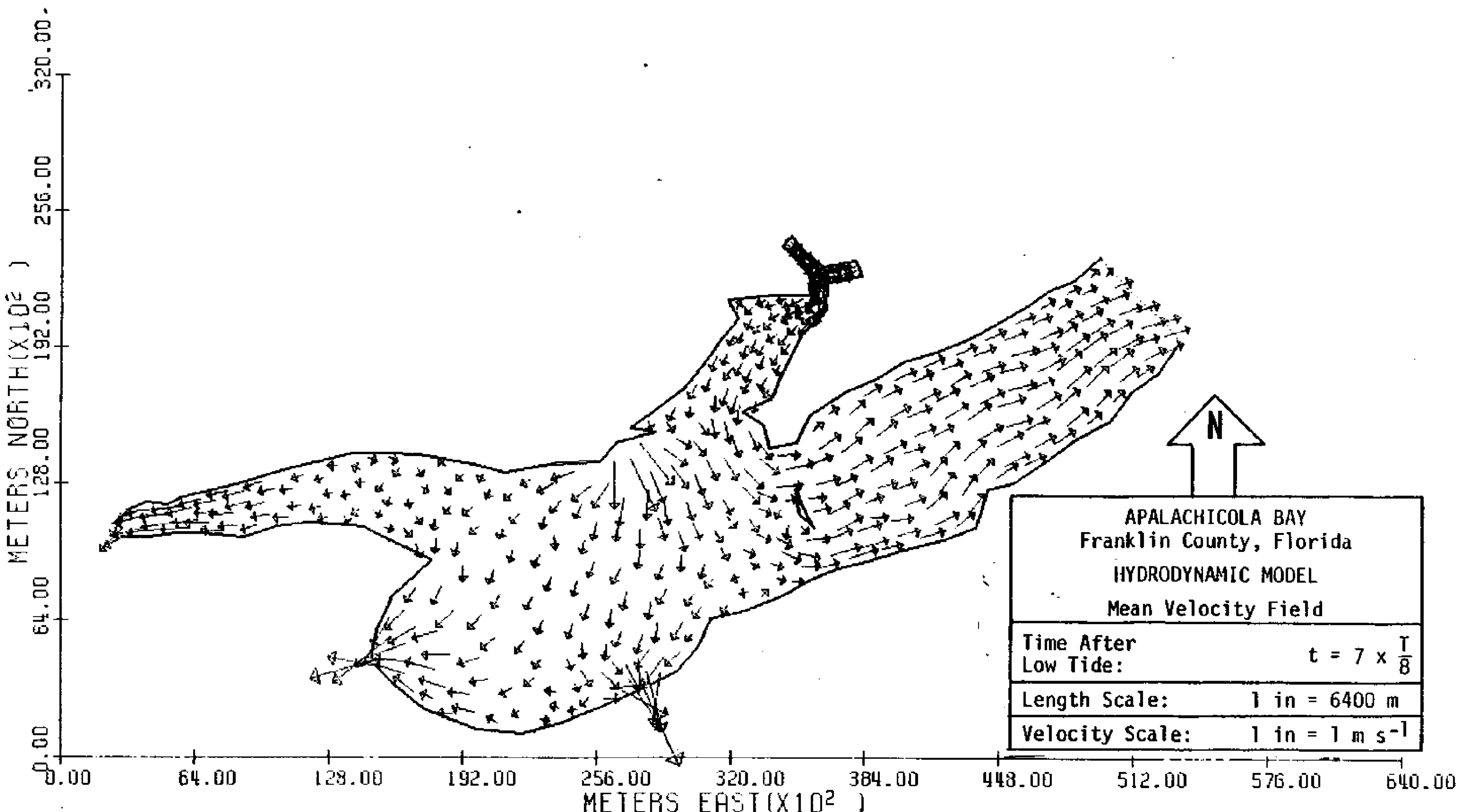
448.00
512.00
576.00
640.00

JAN 7



APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 7 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
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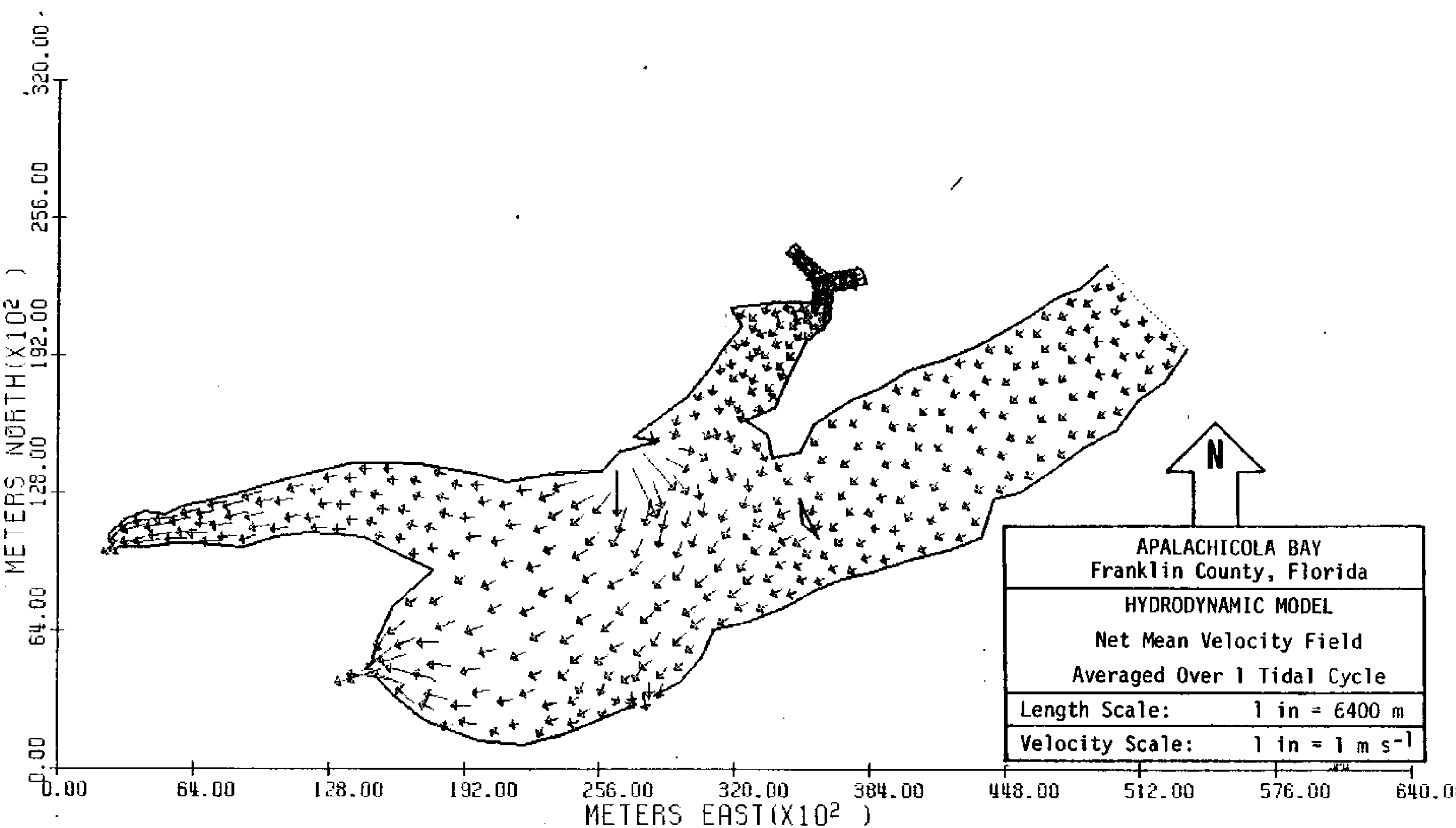
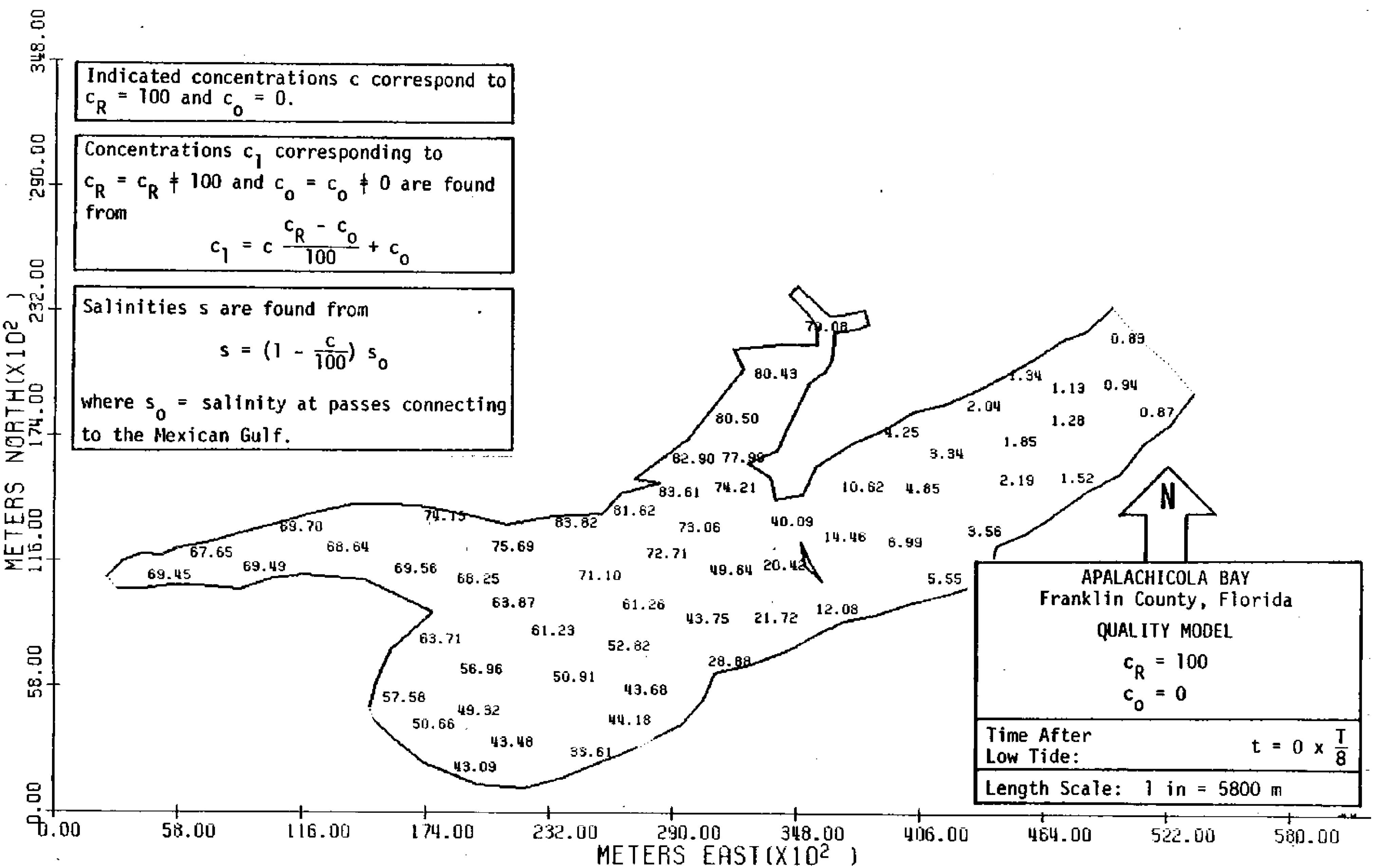
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

JAN 8


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Net Mean Velocity Field
Averaged Over 1 Tidal Cycle
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

JAN 9


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide: $t = 0 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
69.45
67.65
69.49
69.70
68.64
69.56
74.15
68.25
75.69
63.87
63.71
56.96
57.58
49.32
50.66
43.48
43.09
61.23
50.91
35.61
44.18
43.68
52.82
61.26
71.10
83.82
81.62
72.71
73.06
83.61
82.90
77.99
74.21
80.50
80.43
79.08
49.64
43.75
20.42
21.72
28.88
40.09
12.08
14.46
10.62
6.99
4.85
5.55
4.25
3.34
3.56
2.04
1.85
2.19
1.34
1.13
1.28
1.52
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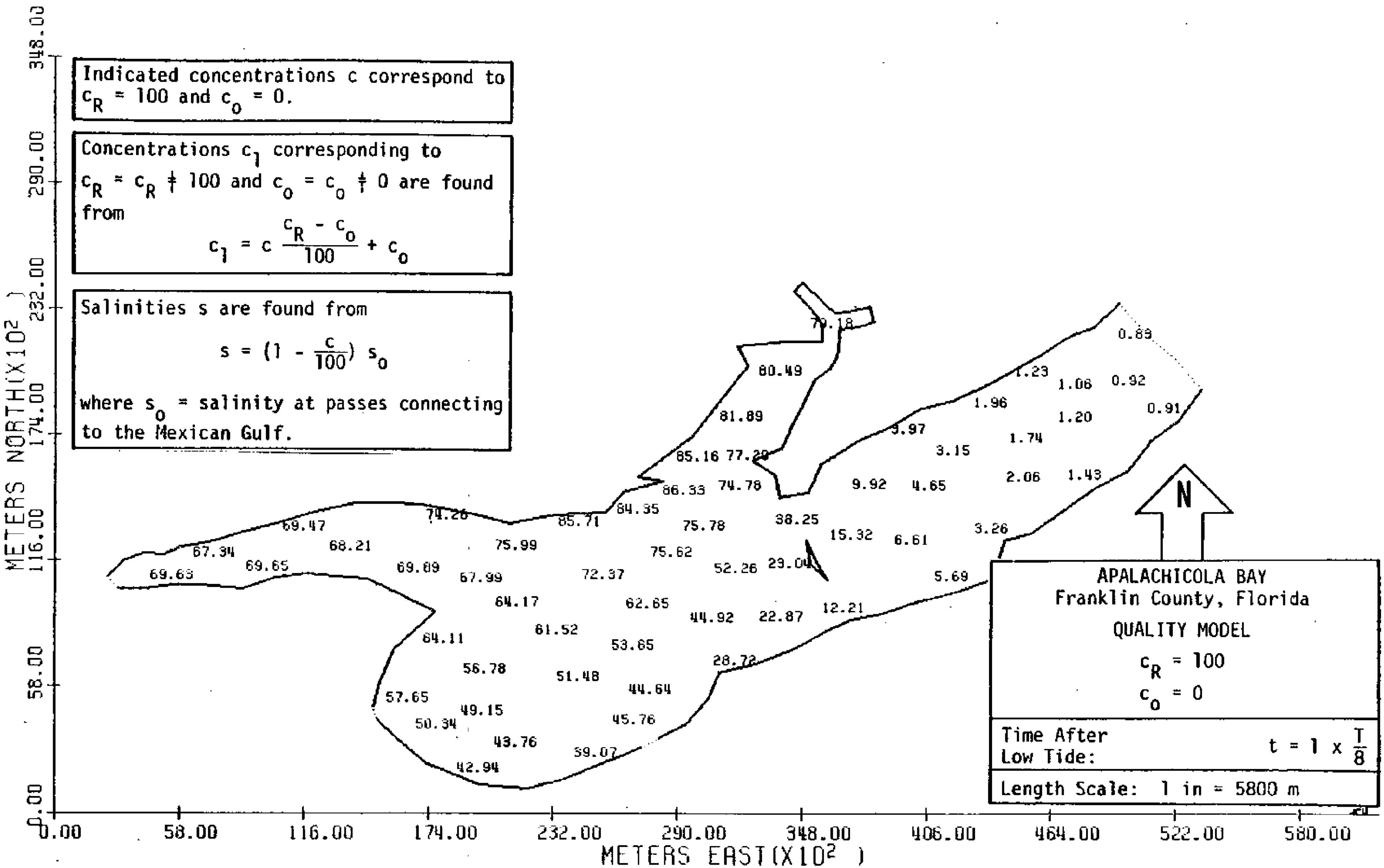
0.87

JAN 10


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide: $t = 1 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH($X10^2$)
METERS EAST($X10^2$)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
79.18
80.49
81.89
85.16
77.29
86.33
74.78
84.35
85.71
74.26
69.47
67.34
69.63
69.65
68.21
69.89
67.99
75.99
72.37
75.78
75.62
38.25
52.26
23.04
15.32
6.61
9.92
4.65
9.97
3.15
1.96
1.74
2.06
1.43
1.23
1.06
1.20
0.92
0.91
0.89
3.26
5.69
12.21
22.87
44.92
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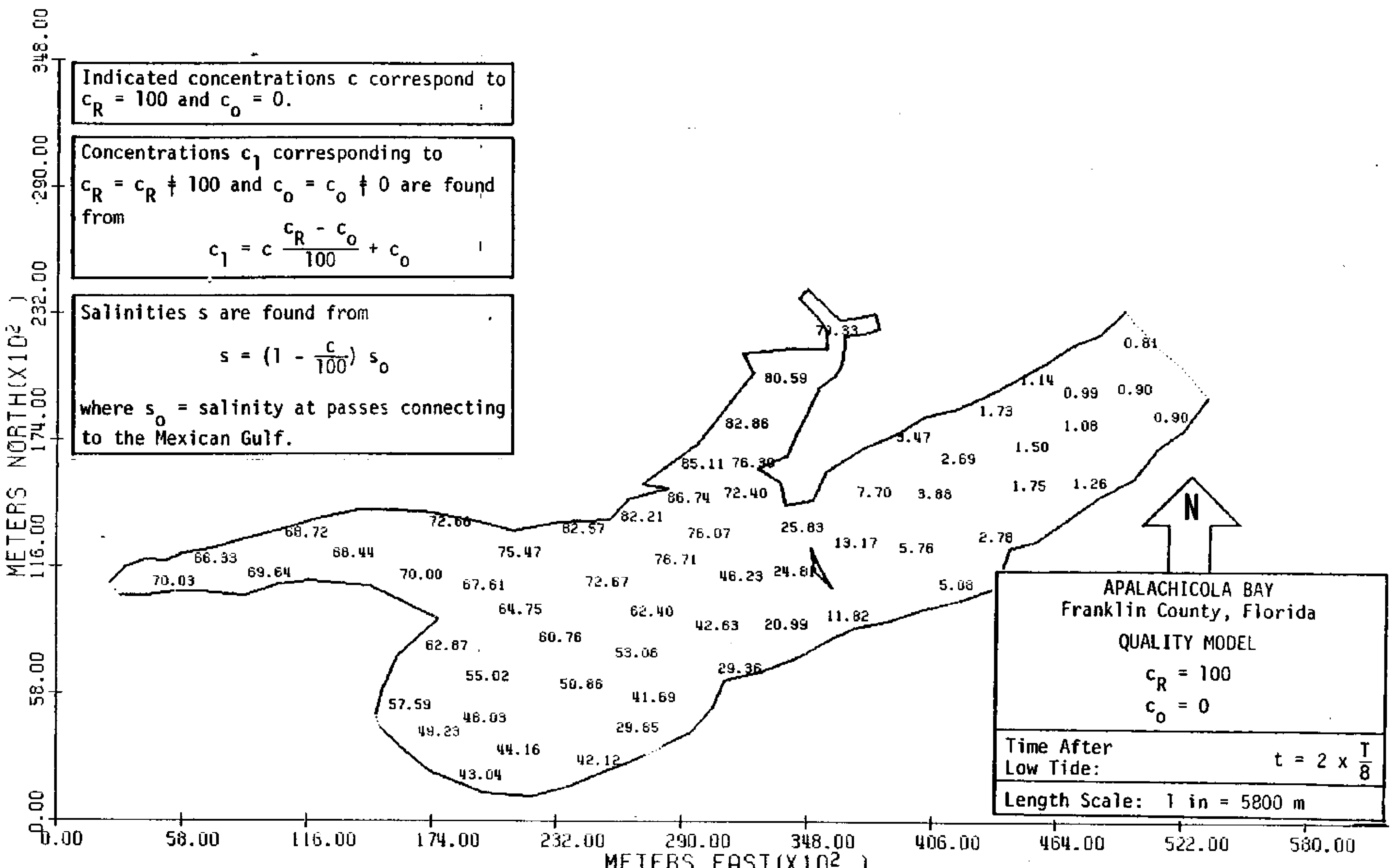
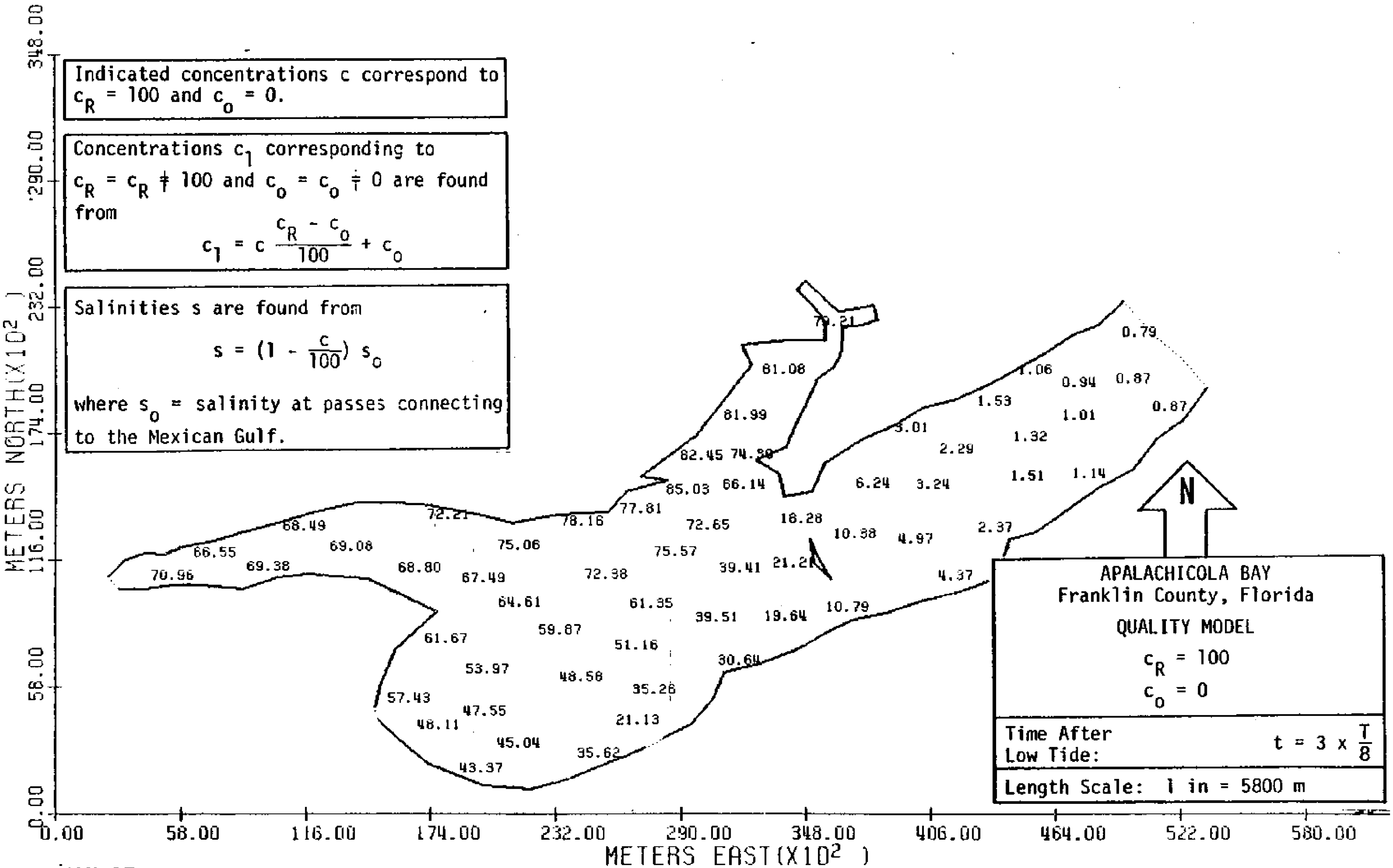
64.17
61.52
64.11
56.78
51.48
53.65
28.72
44.64
45.76
57.65
49.15
50.34
43.76
42.94
59.07
JAN 11



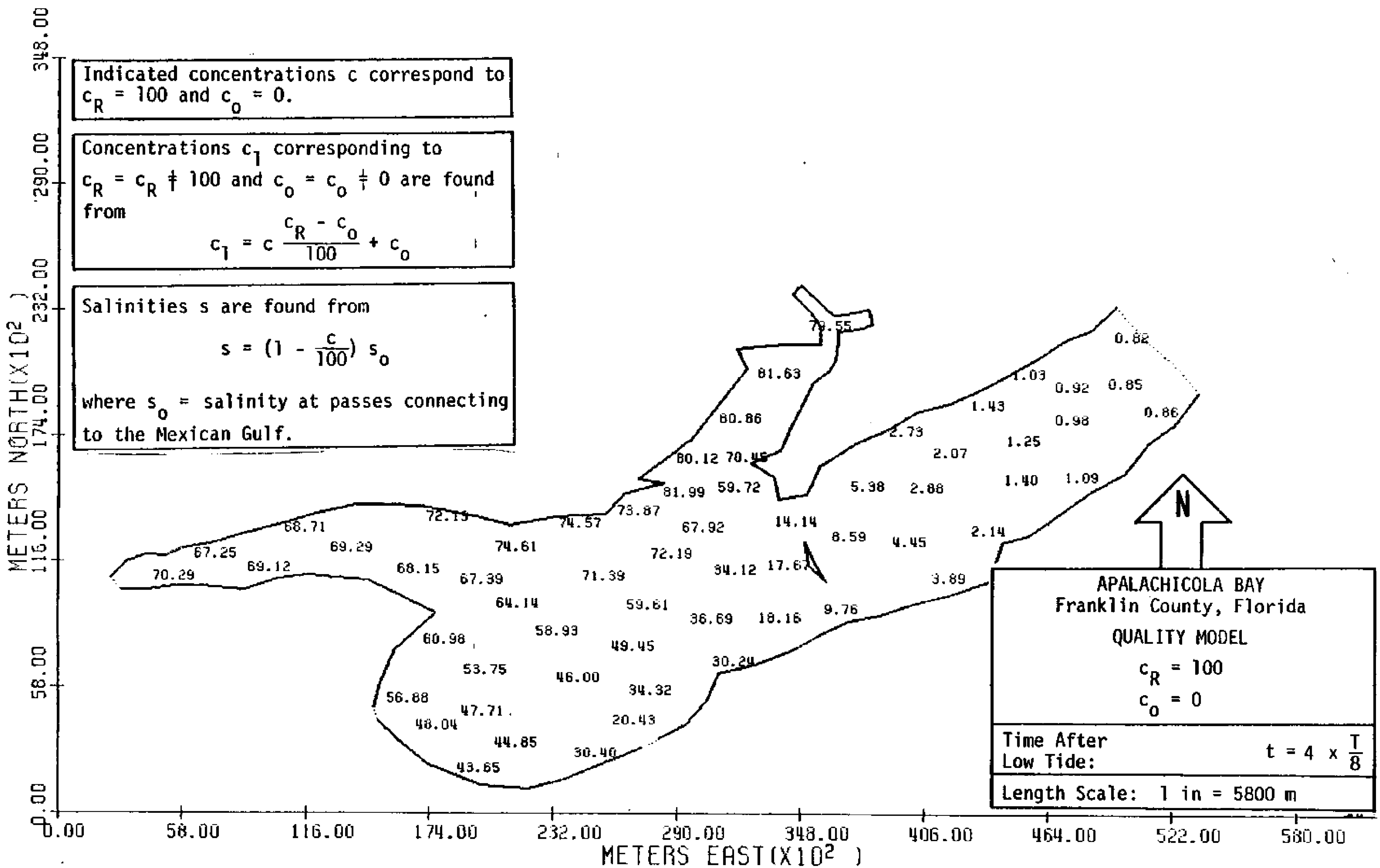
Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c\,\frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = \left(1 - \frac{c}{100}\right) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide: $t = 2 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00

JAN 12



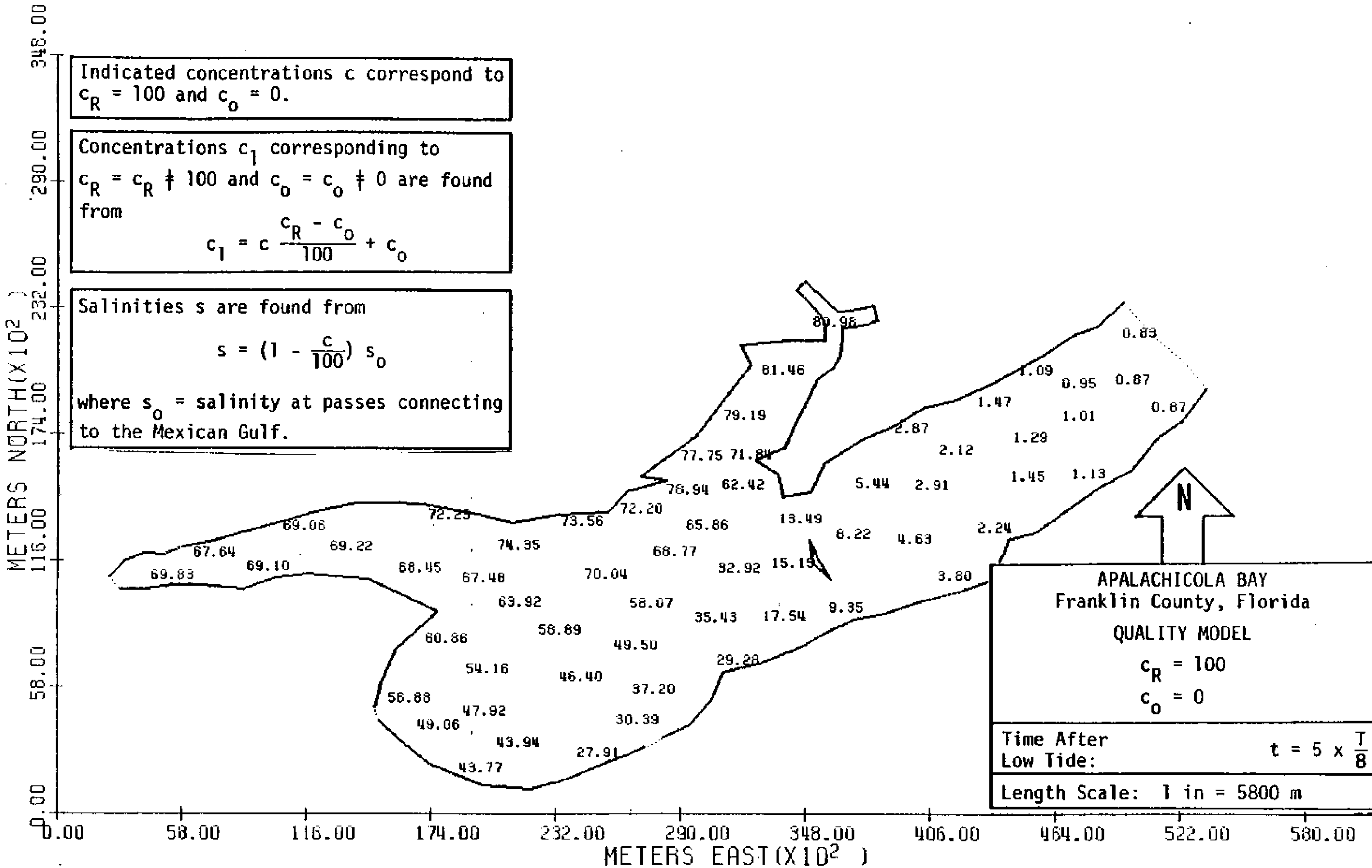
Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100})\, s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 3 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00

JAN 13



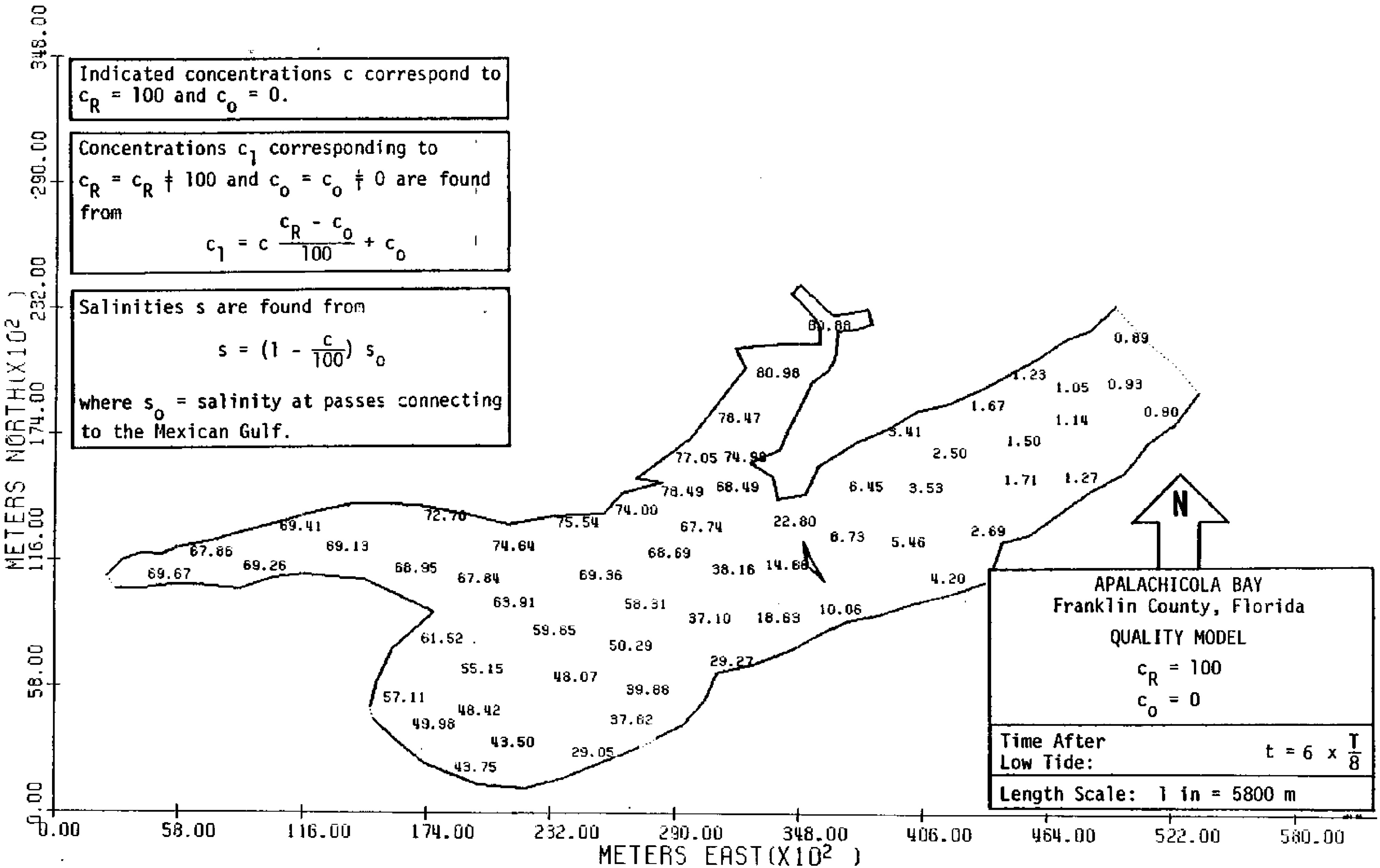
Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 4 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)

JAN 14

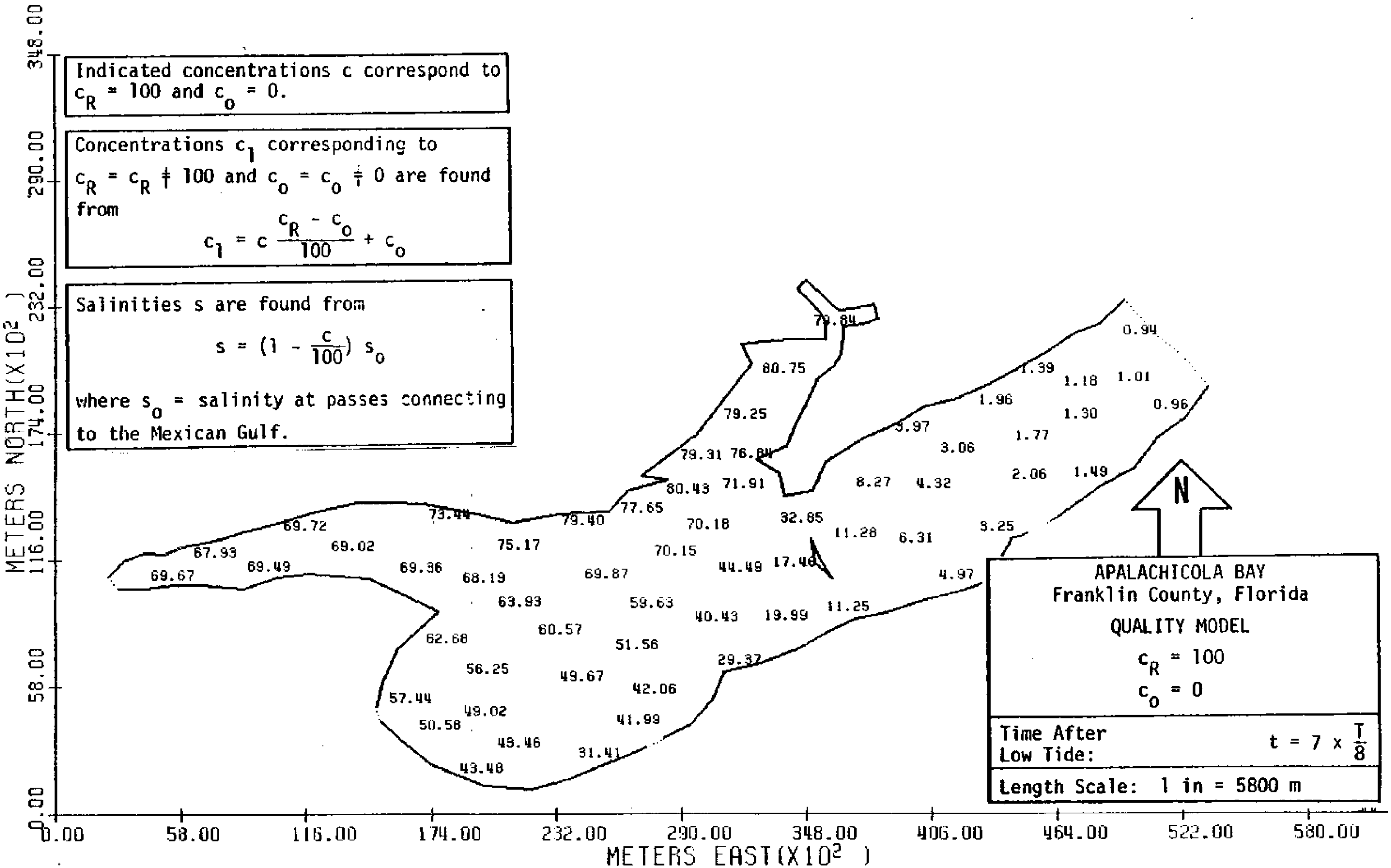


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100})\, s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide: $t = 5 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
69.83
67.64
69.10
69.06
69.22
68.45
72.23
67.48
74.35
63.92
60.86
54.16
56.88
49.06
47.92
43.94
43.77
73.56
58.89
46.40
70.04
72.20
68.77
58.07
49.50
37.20
30.39
27.91
76.94
77.75
71.84
79.19
81.46
80.96
62.42
65.86
92.92
35.43
17.54
15.15
13.49
29.28
9.35
8.22
5.44
4.63
2.91
2.87
2.12
3.80
2.24
1.47
1.29
1.45
1.09
1.01
1.13
0.95
0.87
0.85
0.87

JAN 15


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100})\, s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide: $t = 6 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
80.98
78.47
77.05
78.49
68.49
74.00
67.74
22.80
6.73
5.46
6.45
3.53
2.50
1.67
1.23
1.05
0.93
0.89
0.90
1.14
1.50
1.71
1.27
2.69
4.20
10.06
14.68
38.16
68.69
72.70
75.54
74.64
69.41
69.13
67.86
69.67
69.26
68.95
67.84
69.36
63.91
61.52
59.65
58.31
37.10
18.63
50.29
55.15
48.07
39.88
29.27
57.11
48.42
49.98
43.50
37.62
29.05
43.75

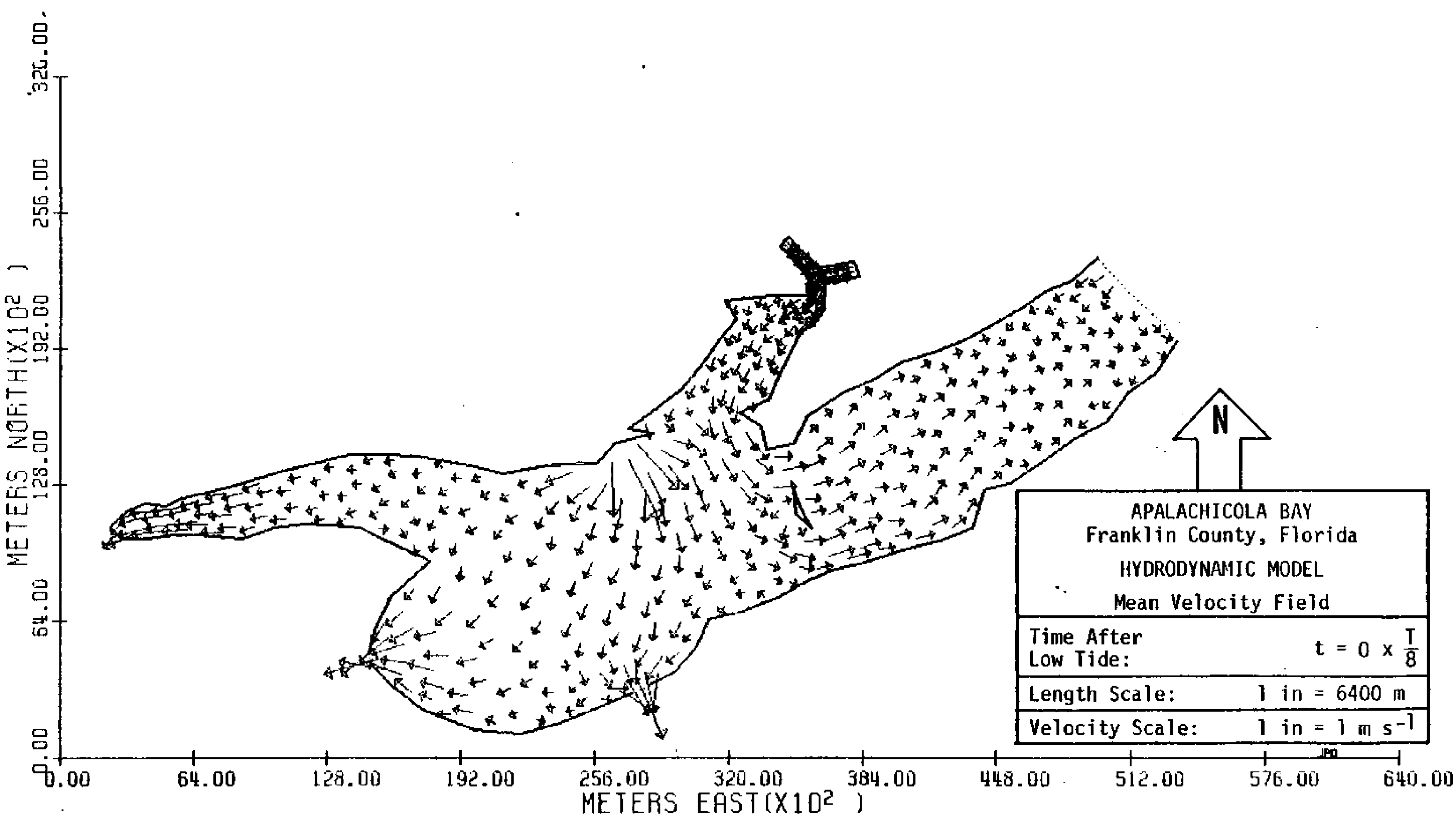
JAN 16


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100})\, s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 7 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00

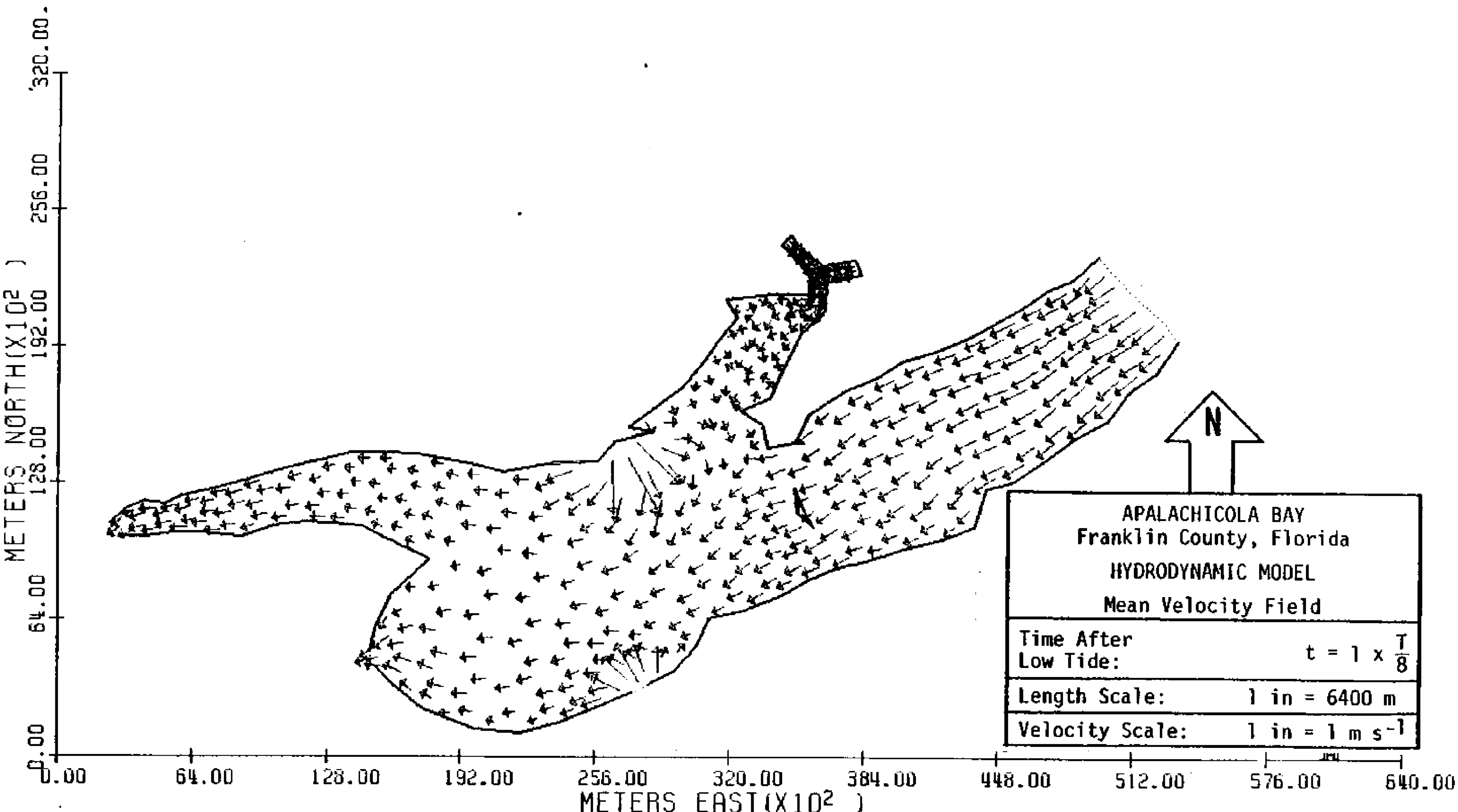
JAN 17

FEBRUARY

FEB 1 through FEB 8:	Vertically averaged velocities v_m given at time increments equal to one eighth of the tidal period beginning at low tide.
FEB 9:	Net values of vertically averaged velocities. Time averaged over one tidal cycle.
FEB 10 through FEB 17:	Vertically averaged pollutant concentration corresponding to river concentration c_R = 100 and concentration c_0 = 0 at all inlets to bay. Concentrations given at time increments equal to one eighth of the tidal period beginning at low tide.

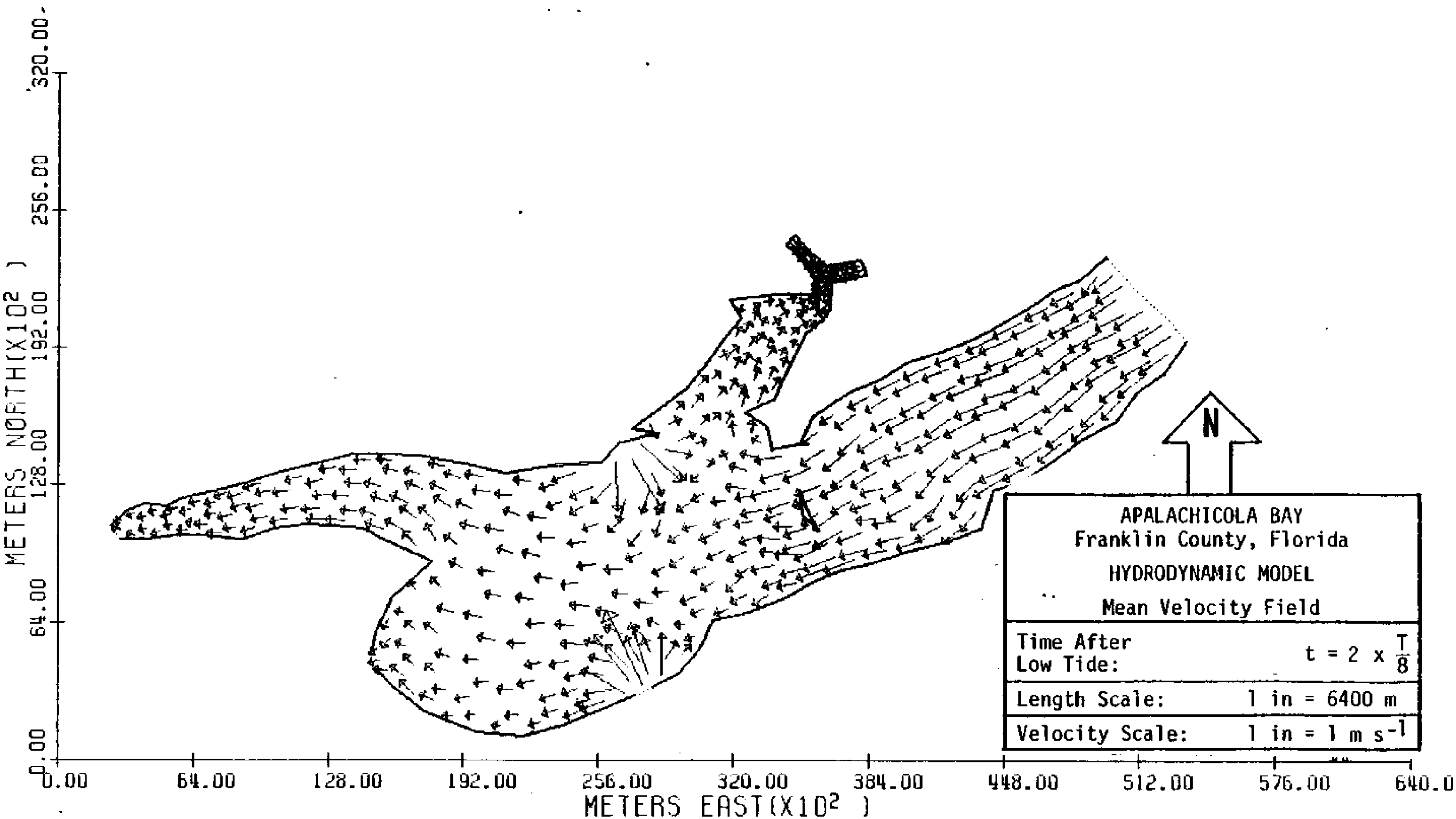

APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 0 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

FEB 1

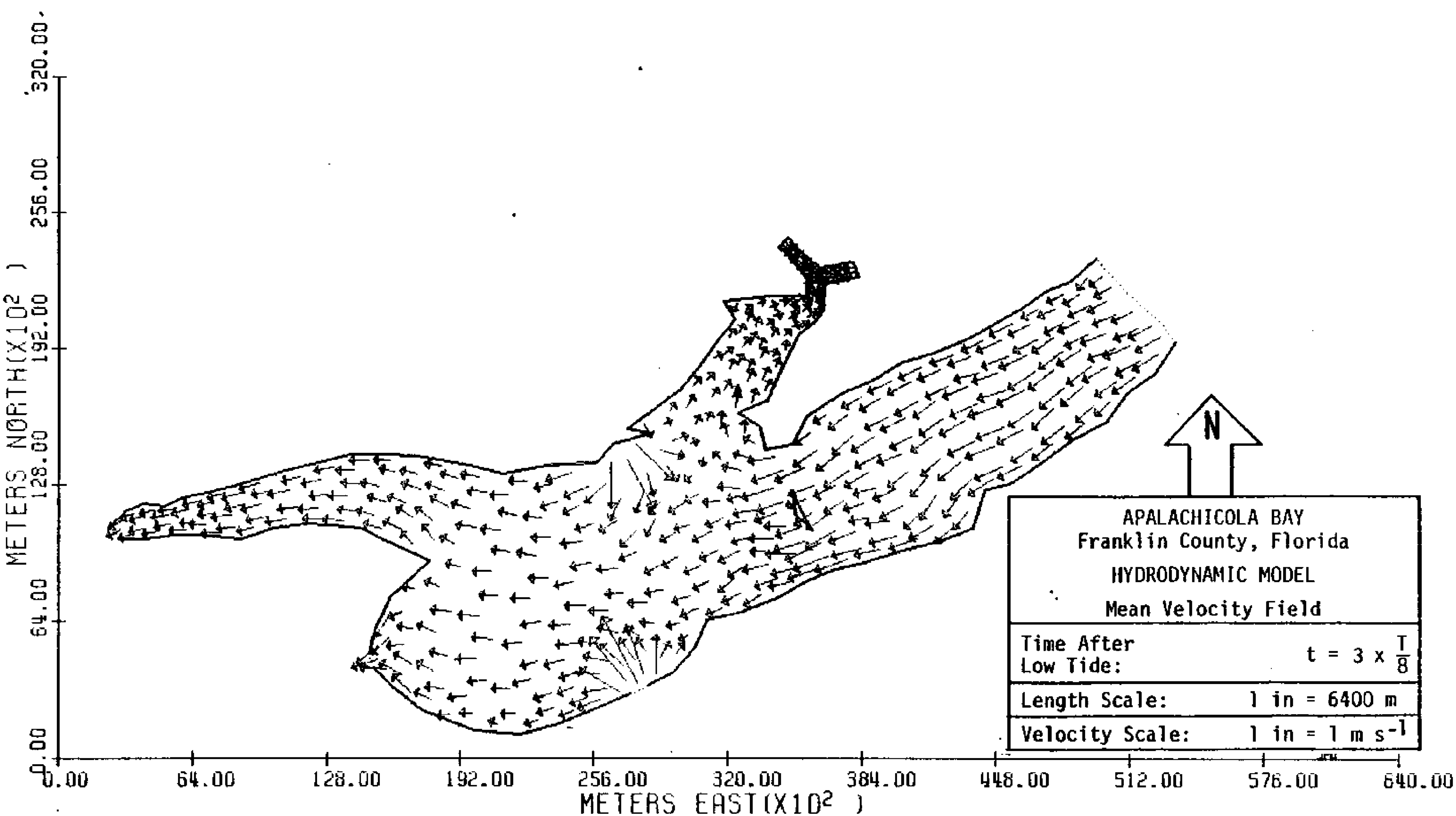


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 1 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

FEB 2

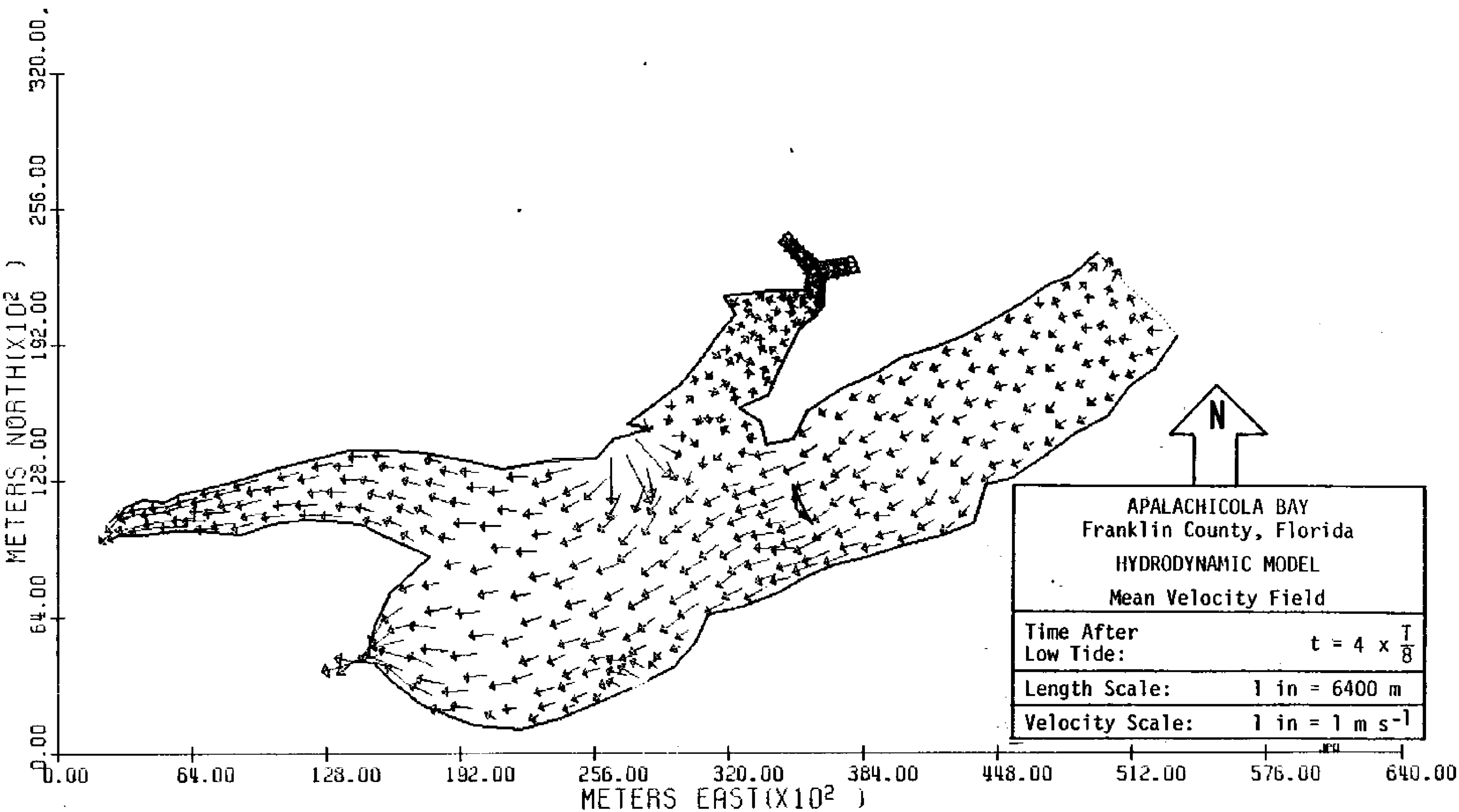

APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 2 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

FEB 3



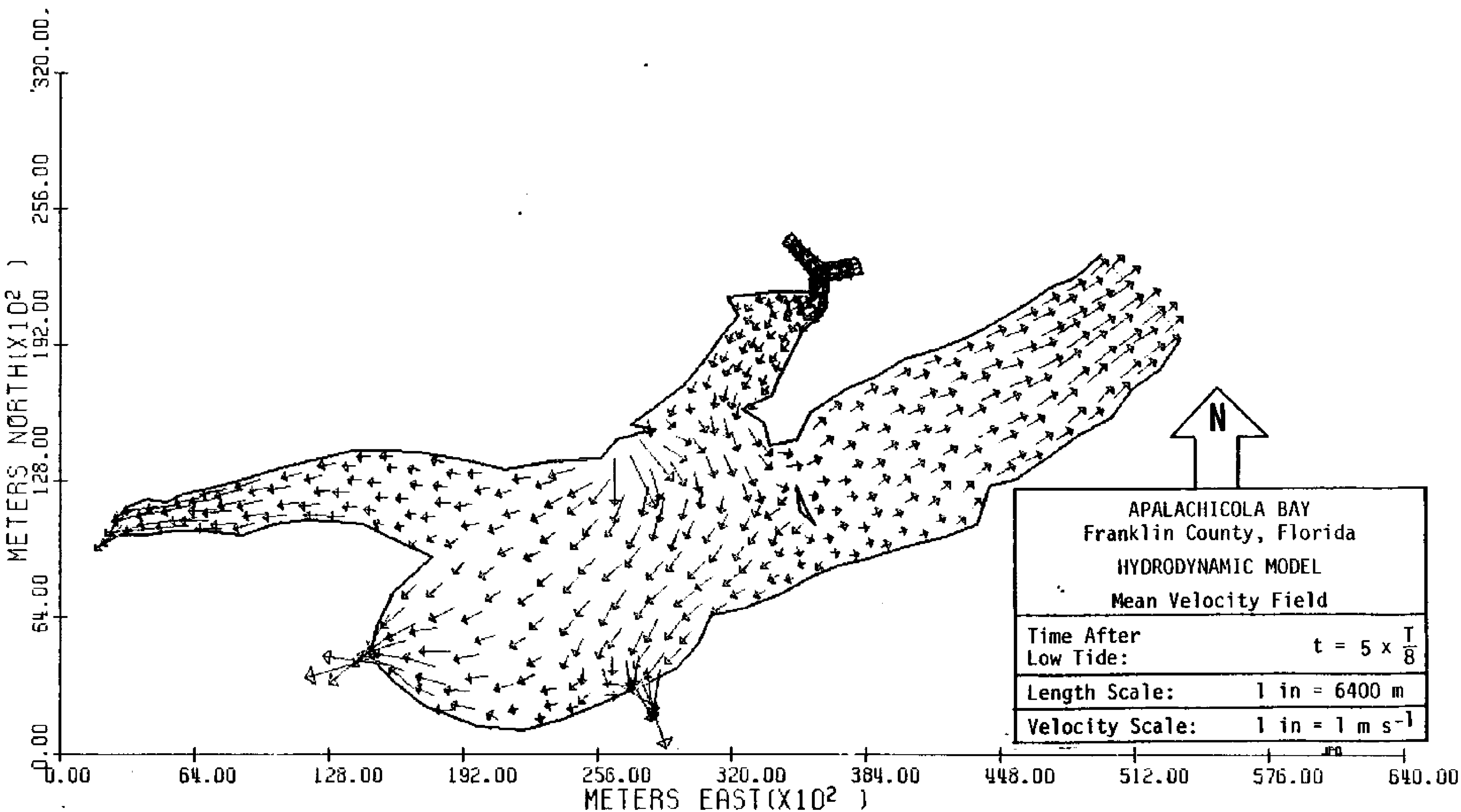
METERS NORTH(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00
N
APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 3 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s⁻¹

FEB 4



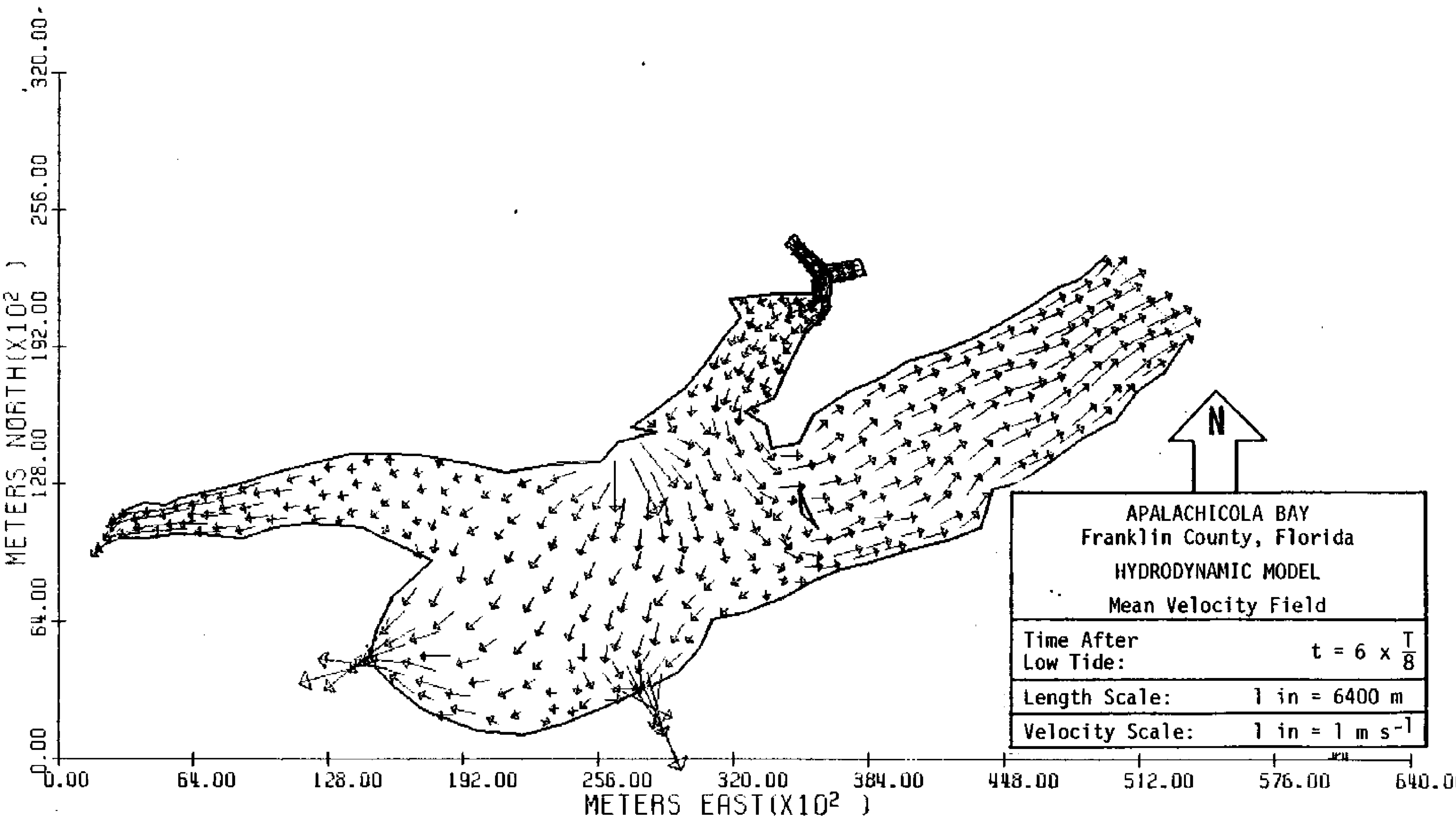
APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide:
t = 4 x T/8
Length Scale:
1 in = 6400 m
Velocity Scale:
1 in = 1 m s-1
N
METERS NORTH(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

FEB 5

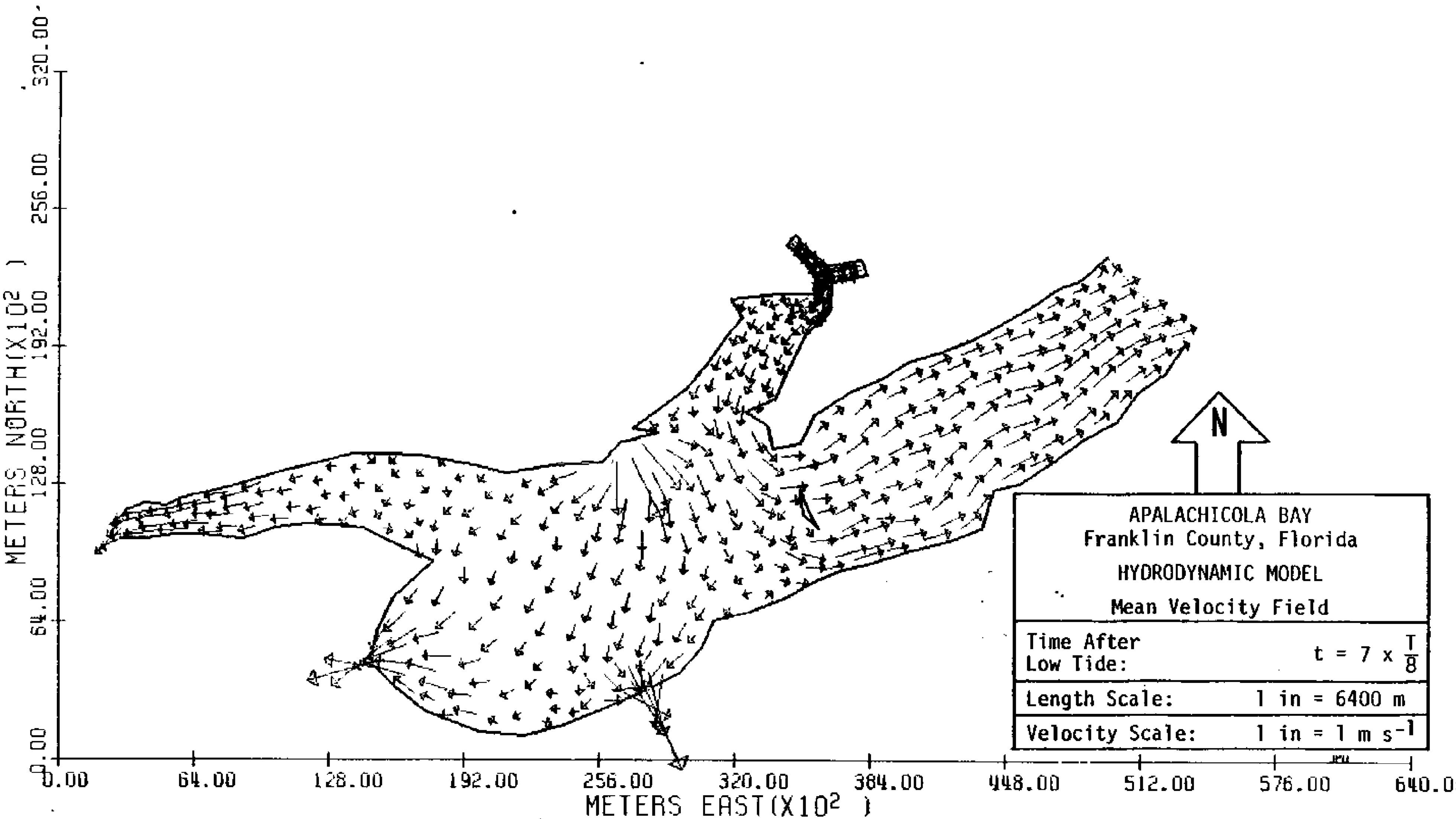


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 5 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

FEB 6

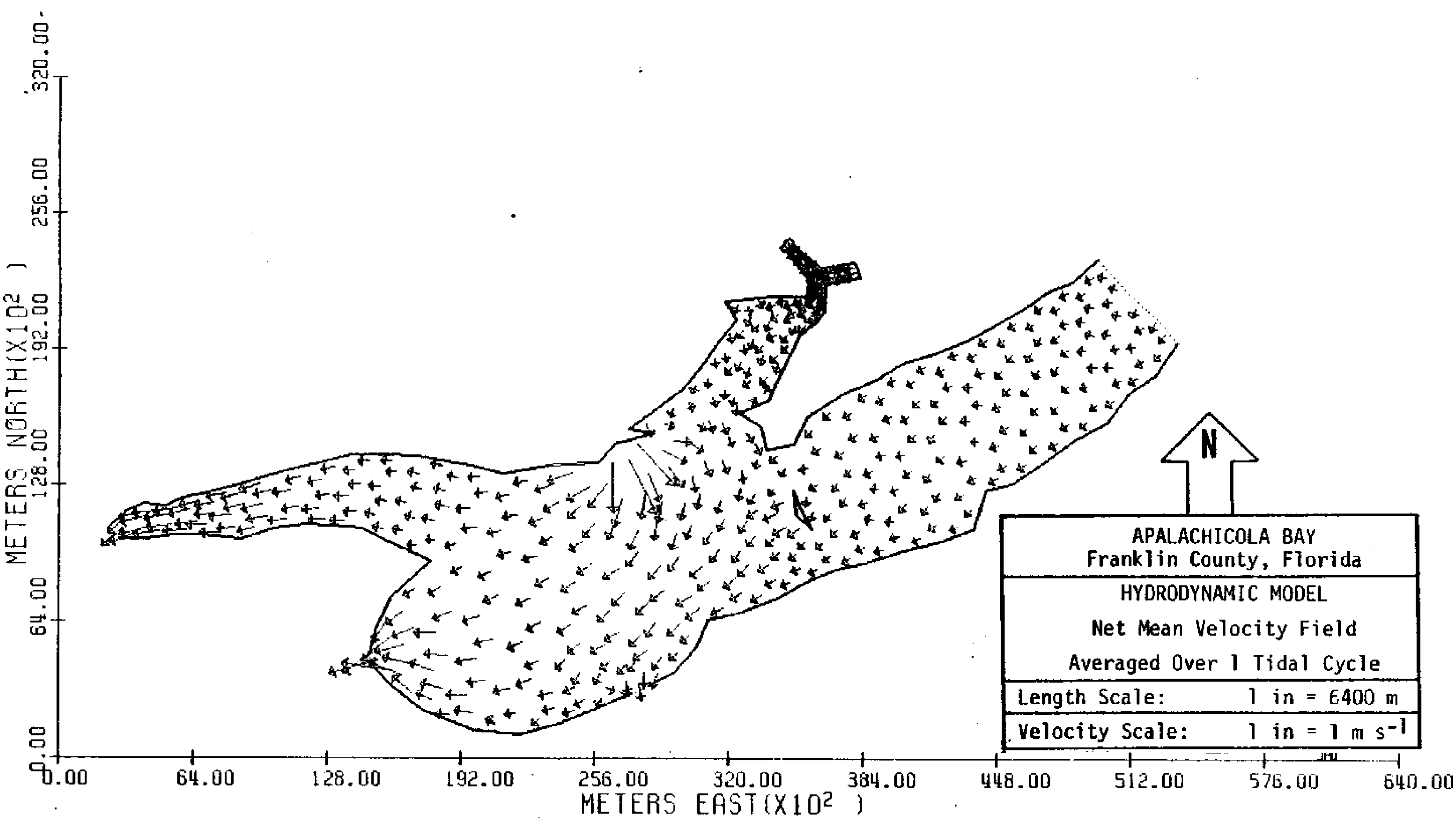

METERS NORTH(X10^2)
320.00
256.00
192.00
128.00
64.00
0.00
METERS EAST(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00
N
APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 6 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}

FEB 7

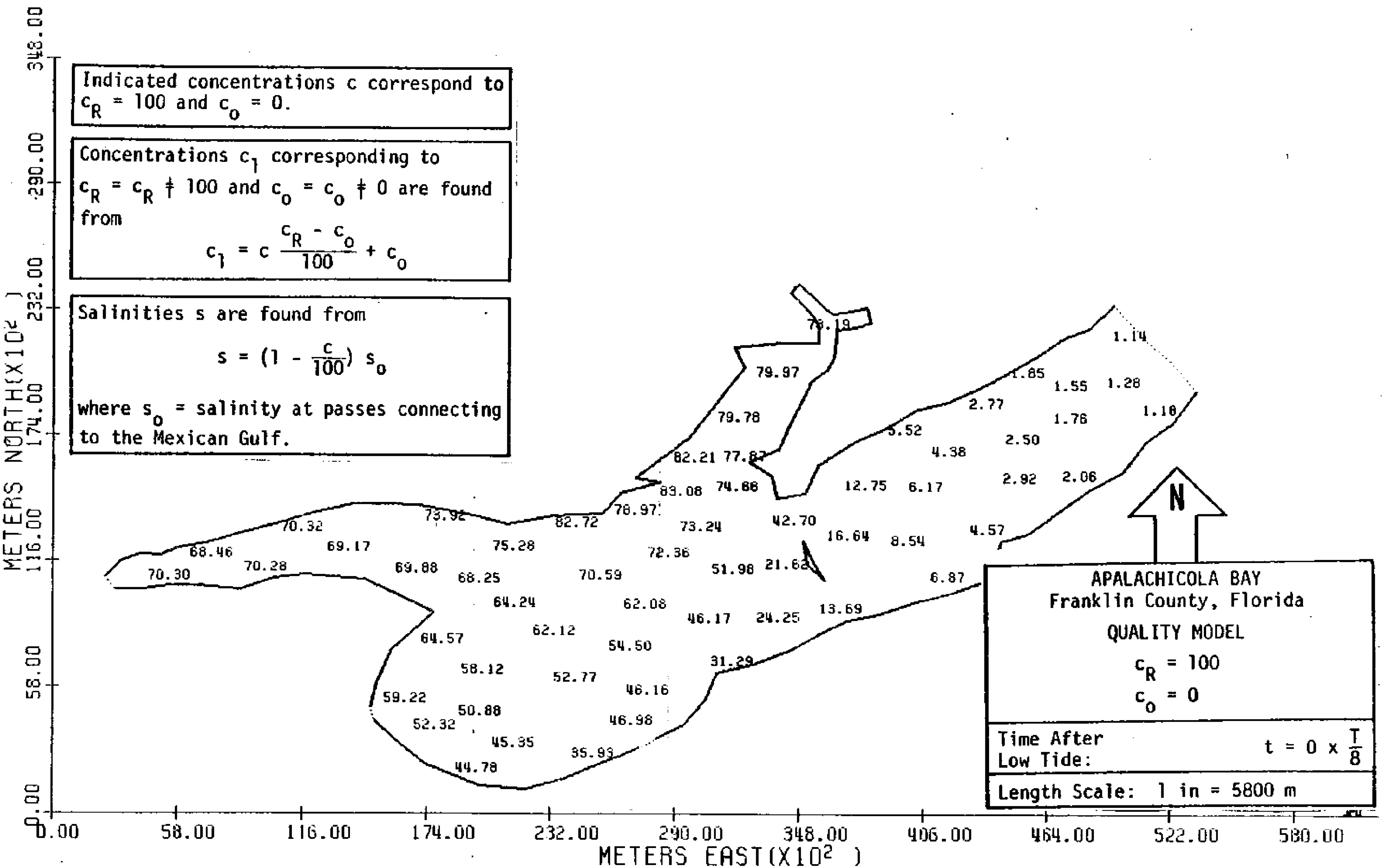


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide:
$t = 7 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

FEB 8

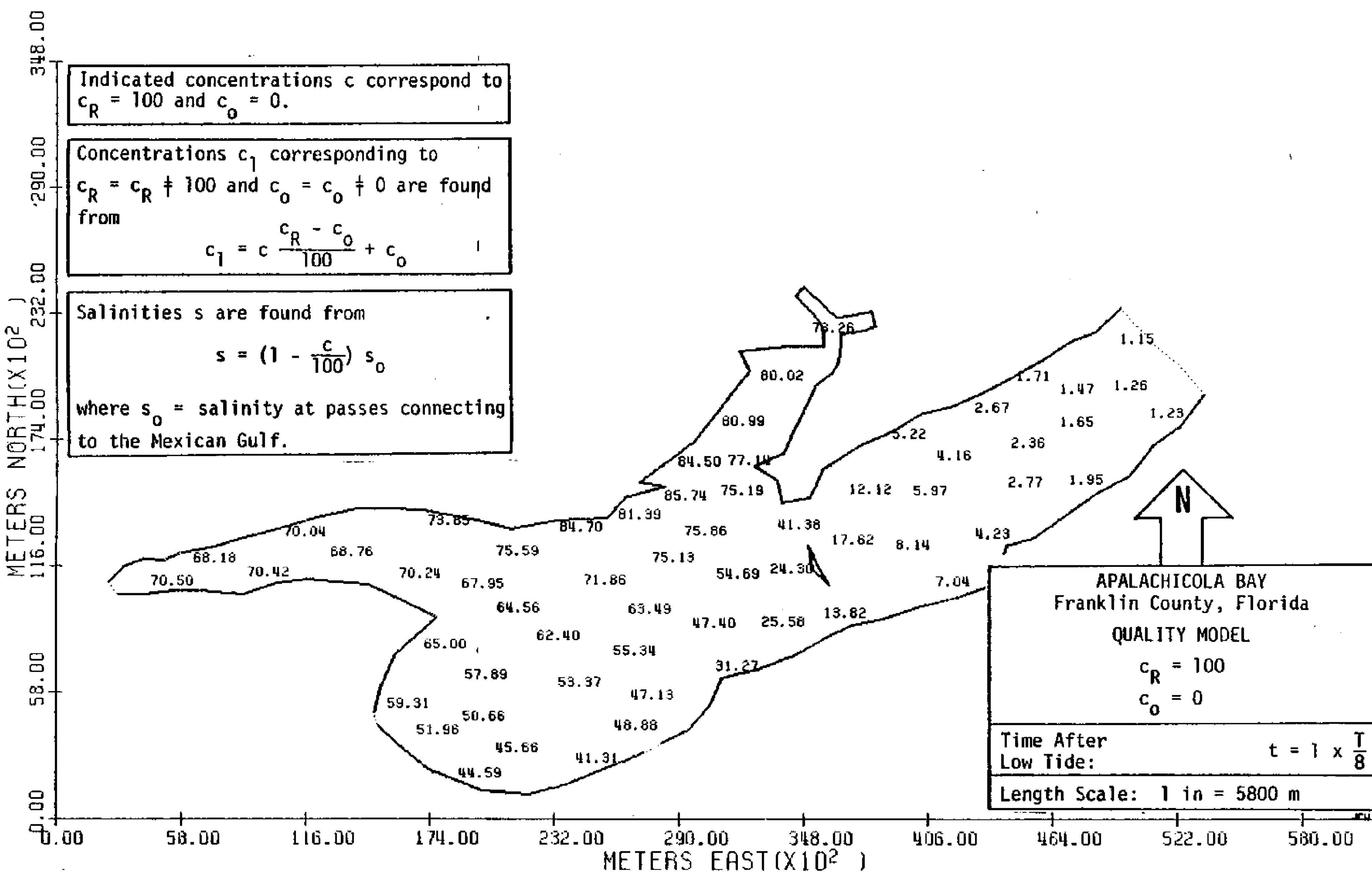

APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Net Mean Velocity Field
Averaged Over 1 Tidal Cycle
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

FEB 9

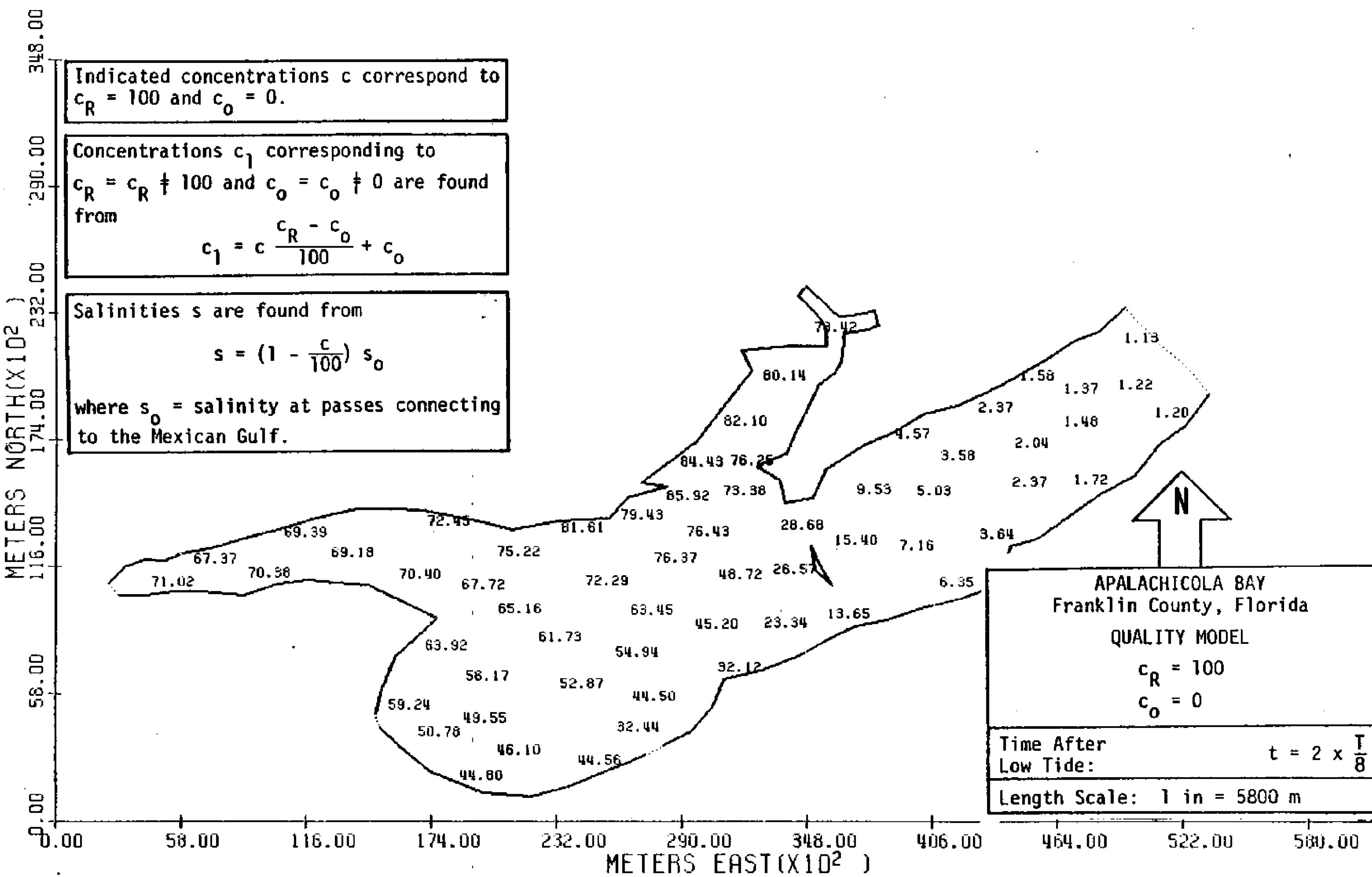


Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c\,\frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = \left(1 - \frac{c}{100}\right) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide: $t = 0 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00

FEB 10

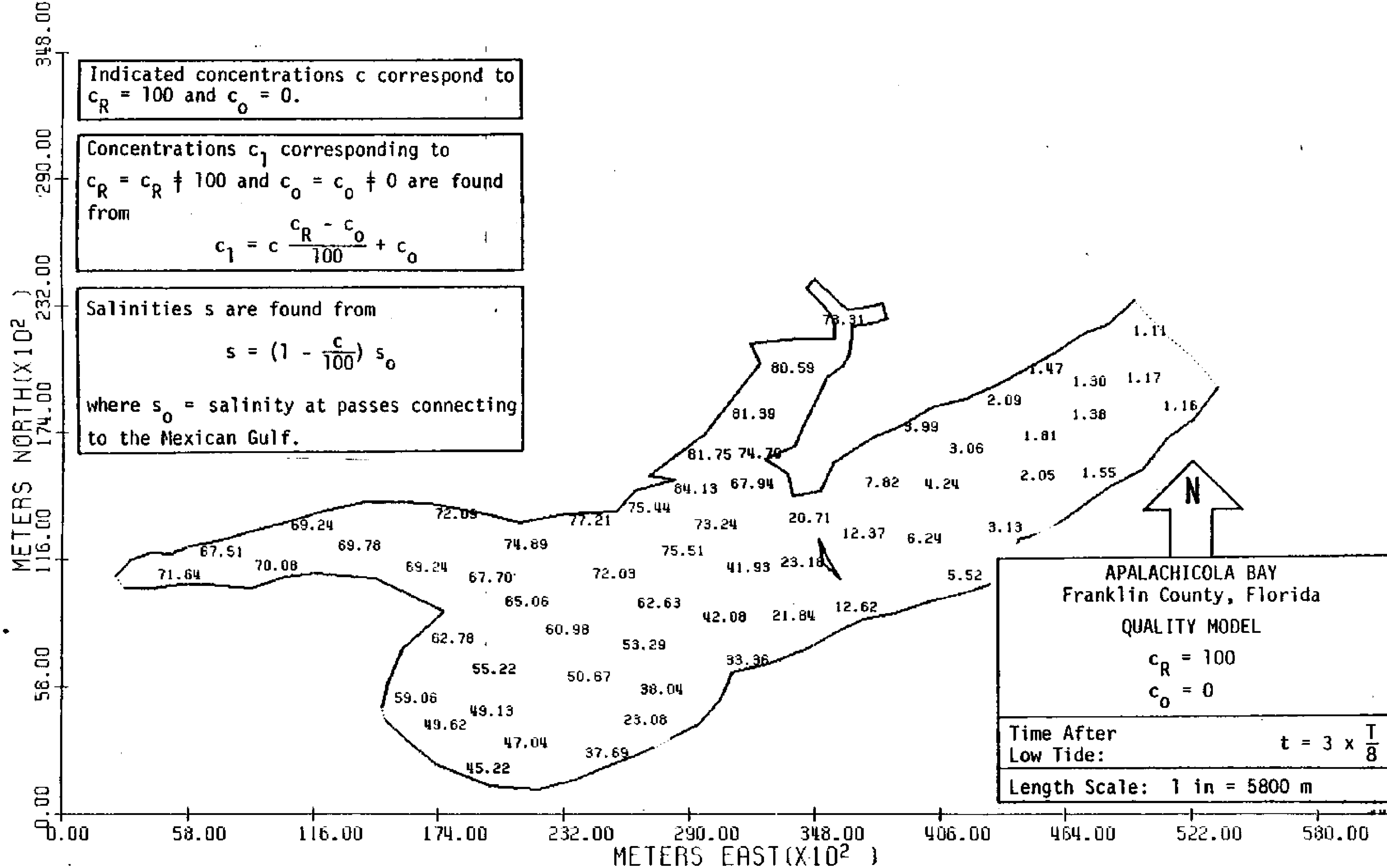

Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c\,\frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100})\, s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide: $t = 1 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
70.50
68.18
70.42
70.04
68.76
70.24
73.85
67.95
75.59
64.56
65.00
57.89
59.31
51.96
50.66
45.66
44.59
62.40
53.37
84.70
71.86
81.39
63.49
55.34
47.13
48.88
41.31
85.74
75.86
75.13
84.50
77.14
75.19
80.99
80.02
78.26
47.40
54.69
25.58
31.27
41.38
24.30
13.82
17.62
12.12
5.22
5.97
8.14
4.16
7.04
2.67
4.23
2.36
2.77
1.71
1.47
1.65
1.95
1.15
1.26
1.23

FEB 11

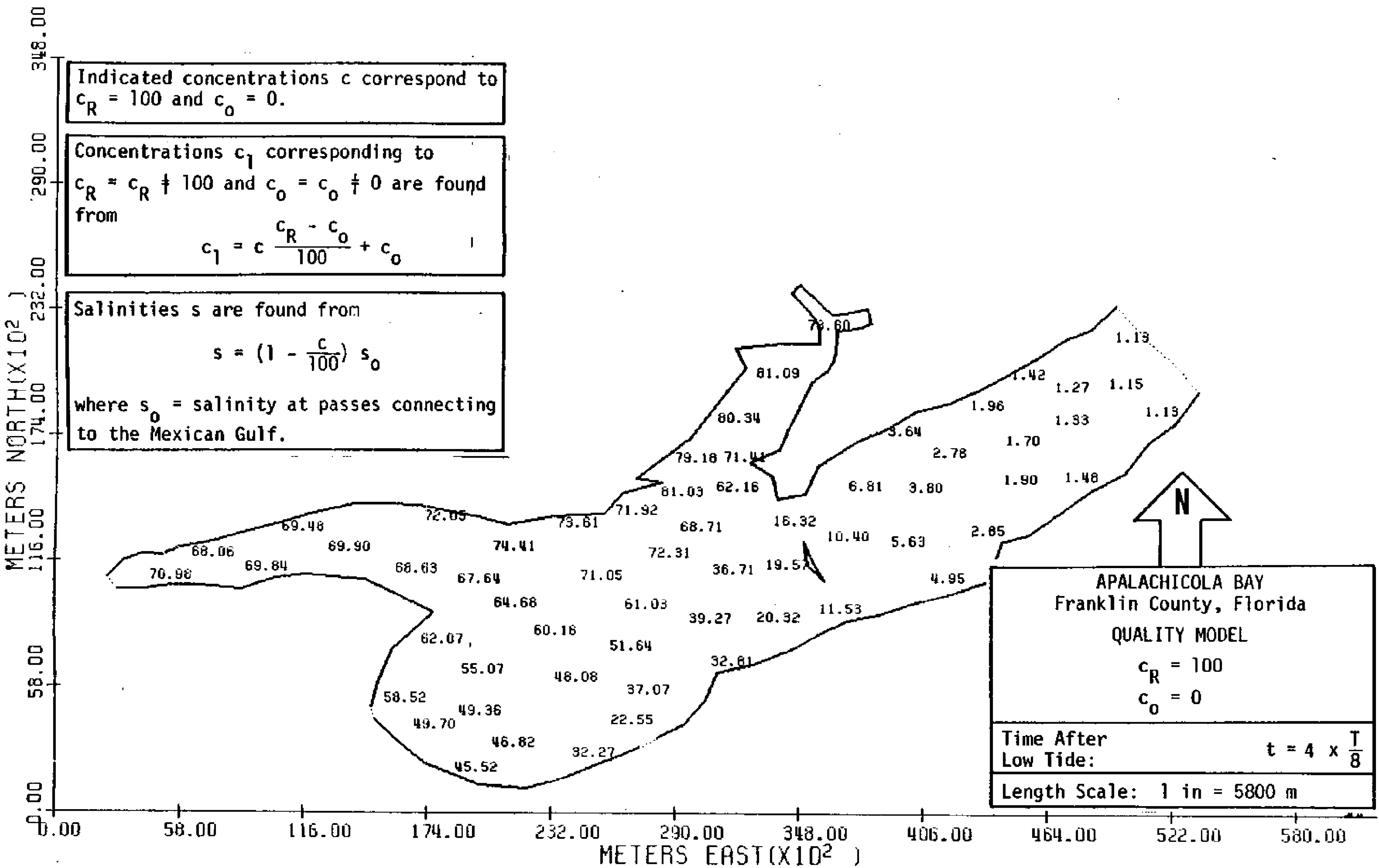


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 2 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
71.02
67.37
70.38
69.39
69.18
70.40
72.45
67.72
75.22
65.16
63.92
58.17
59.24
49.55
50.78
46.10
44.80
61.73
52.87
44.56
81.61
72.29
63.45
54.94
44.50
32.44
79.43
76.37
76.43
85.92
84.43
76.25
73.38
82.10
80.14
73.42
48.72
45.20
23.34
32.12
28.68
26.57
15.40
13.65
9.53
7.16
6.35
5.03
4.57
3.58
3.64
2.37
2.04
2.37
1.72
1.58
1.37
1.48
1.13
1.22
1.20

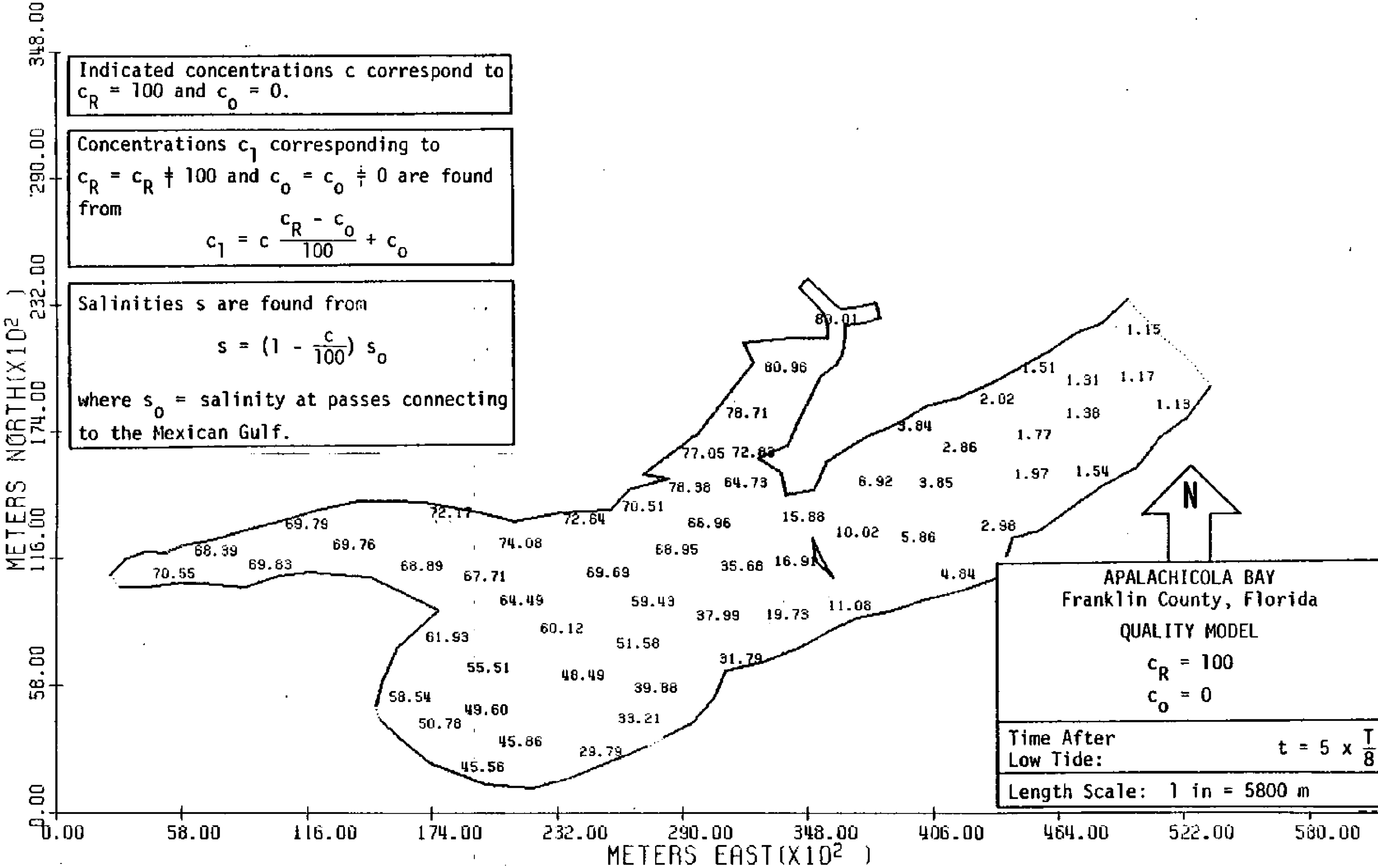
FEB 12


Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100})\, s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide:
$t = 3 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
71.64
67.51
70.08
69.24
69.78
69.24
72.09
67.70
74.89
77.21
65.06
62.78
55.22
59.06
49.62
49.13
47.04
45.22
60.98
50.67
37.69
72.03
75.44
75.51
62.63
53.29
38.04
23.08
84.13
81.75
74.70
67.94
73.24
41.93
42.08
33.36
81.39
80.59
20.71
23.18
21.84
12.62
12.37
7.82
6.24
4.24
3.99
3.06
5.52
3.13
2.09
1.81
2.05
1.47
1.30
1.38
1.55
1.11
1.17
1.16

FEB 13

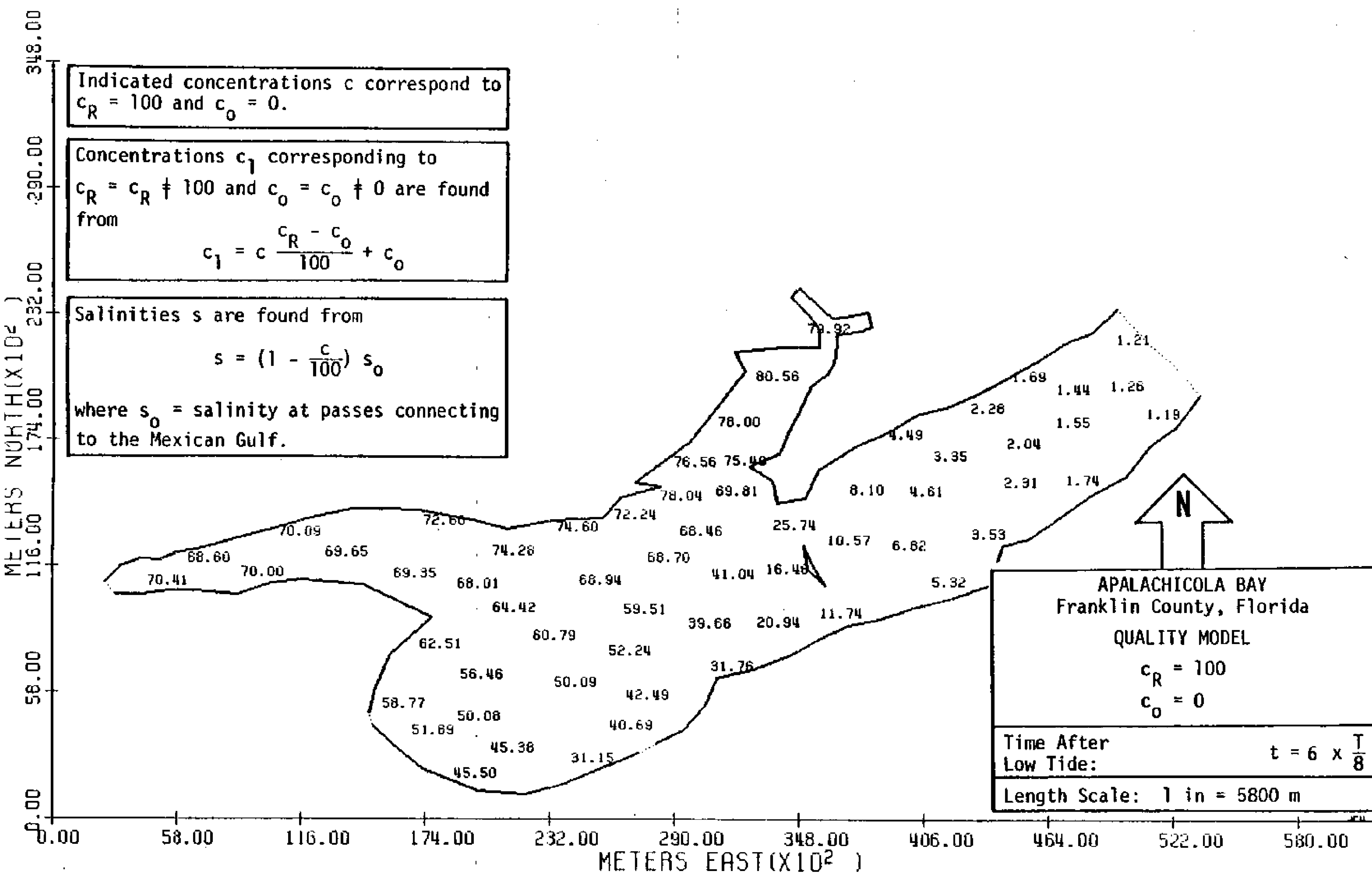

Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100})\, s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide: $t = 4 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
70.98
68.06
69.84
69.48
69.90
68.63
72.05
67.64
74.41
64.68
62.07
55.07
58.52
49.36
49.70
46.82
45.52
60.16
48.08
73.61
71.05
51.64
37.07
22.55
32.27
61.03
72.31
68.71
71.92
81.03
62.16
79.18
71.41
80.34
81.09
39.27
36.71
20.32
19.57
16.32
32.81
11.53
10.40
6.81
5.63
3.80
2.78
3.64
4.95
2.85
1.90
1.70
1.96
1.42
1.48
1.33
1.27
1.15
1.13
1.13

FEB 14

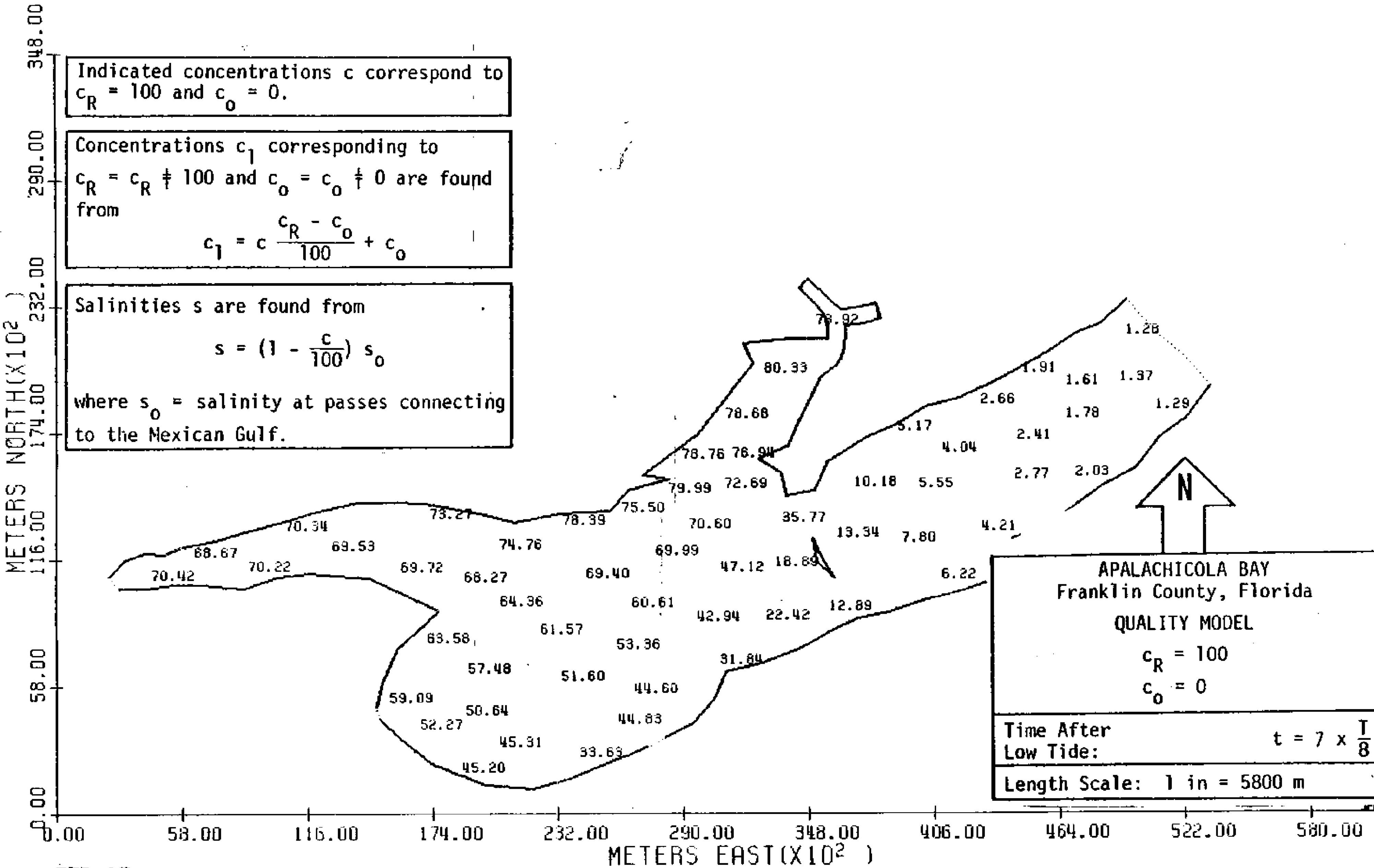


Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c\,\frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = \left(1 - \frac{c}{100}\right) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide: $t = 5 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10[2])
METERS EAST(X10[2])
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
70.55
68.39
69.83
69.79
69.76
68.89
72.17
67.71
74.08
64.49
61.93
55.51
58.54
49.60
50.78
45.86
45.56
72.64
69.69
60.12
48.49
70.51
68.95
59.43
51.58
39.88
33.21
29.79
78.38
66.96
35.68
37.99
31.79
77.05
72.8
64.73
78.71
80.96
80.01
15.88
16.91
19.73
11.08
10.02
6.92
5.86
3.84
3.85
2.86
4.84
2.98
2.02
1.97
1.77
1.51
1.54
1.38
1.31
1.17
1.15
1.13

FEB 15


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100})\, s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 6 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00

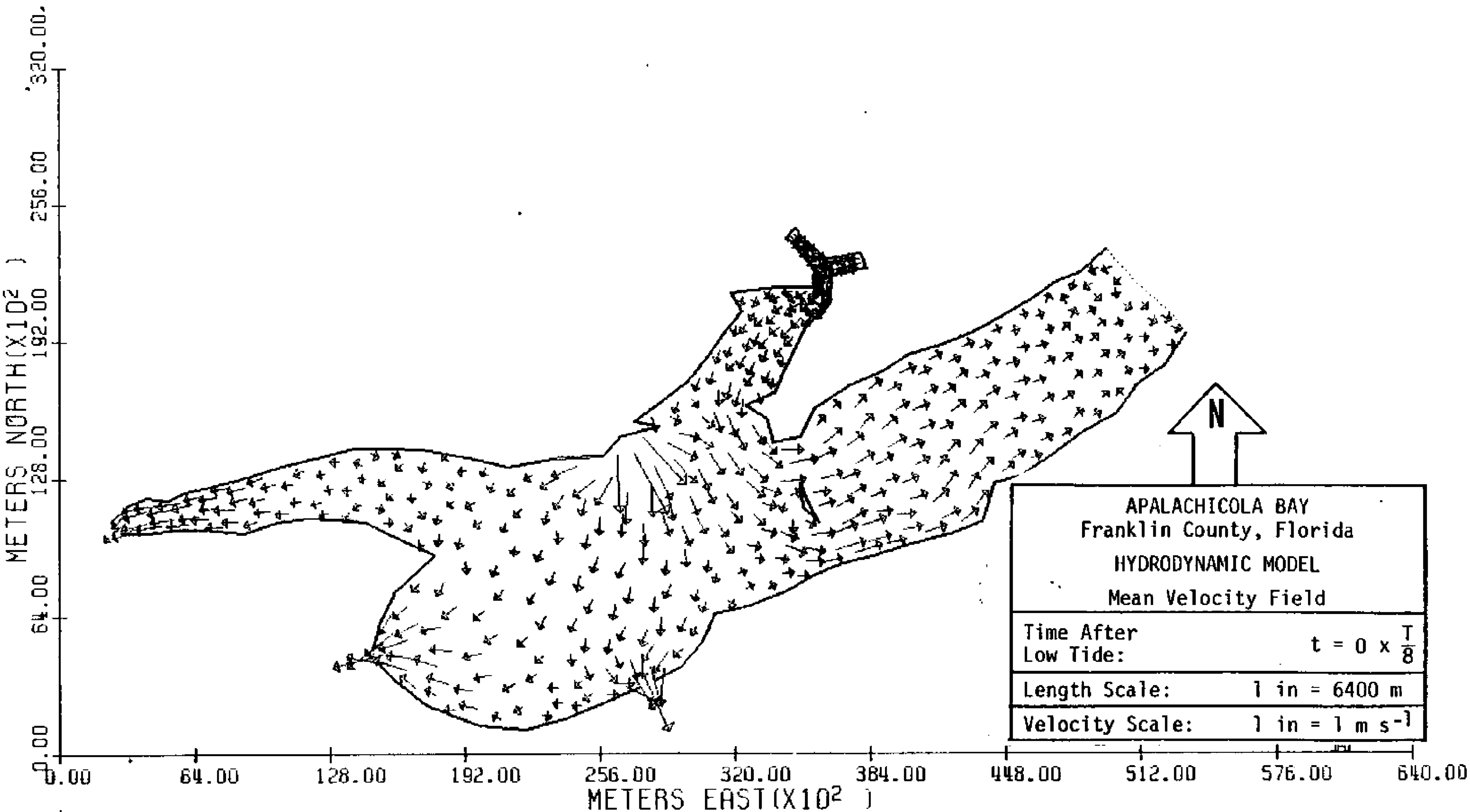
FEB 16


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c\,\frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100})\,s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
N
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 7 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
METERS NORTH(X10^2)
METERS EAST(X10^2)

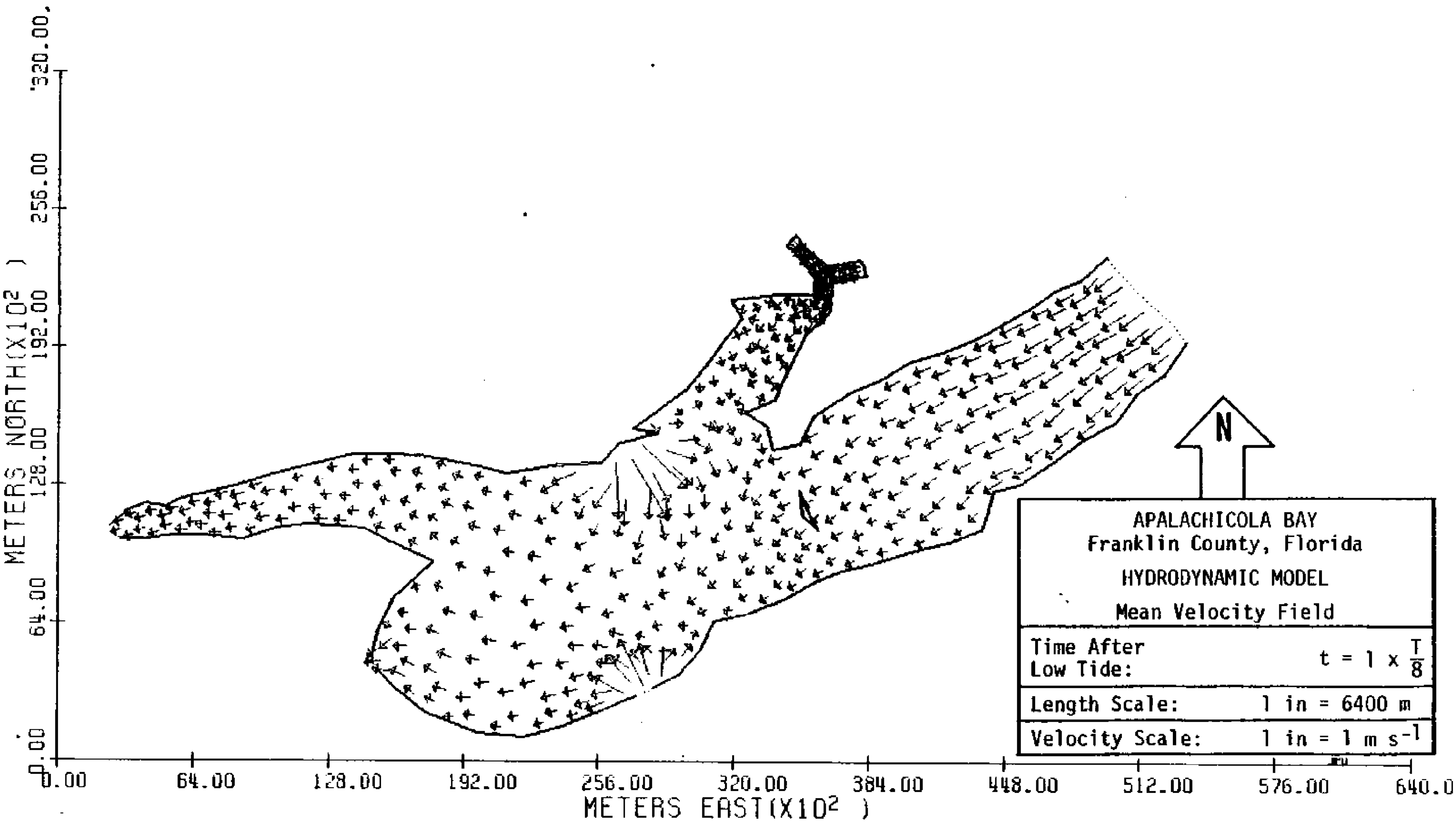
FEB 17

MARCH

MAR 1 through MAR 8:	Vertically averaged velocities v_m given at time increments equal to one eighth of the tidal period beginning at low tide.
MAR 9:	Net values of vertically averaged velocities. Time averaged over one tidal cycle.
MAR 10 through MAR 17:	Vertically averaged pollutant concentration corresponding to river concentration c_R = 100 and concentration c_o = 0 at all inlets to bay. Concentrations given at time increments equal to one eighth of the tidal period beginning at low tide.

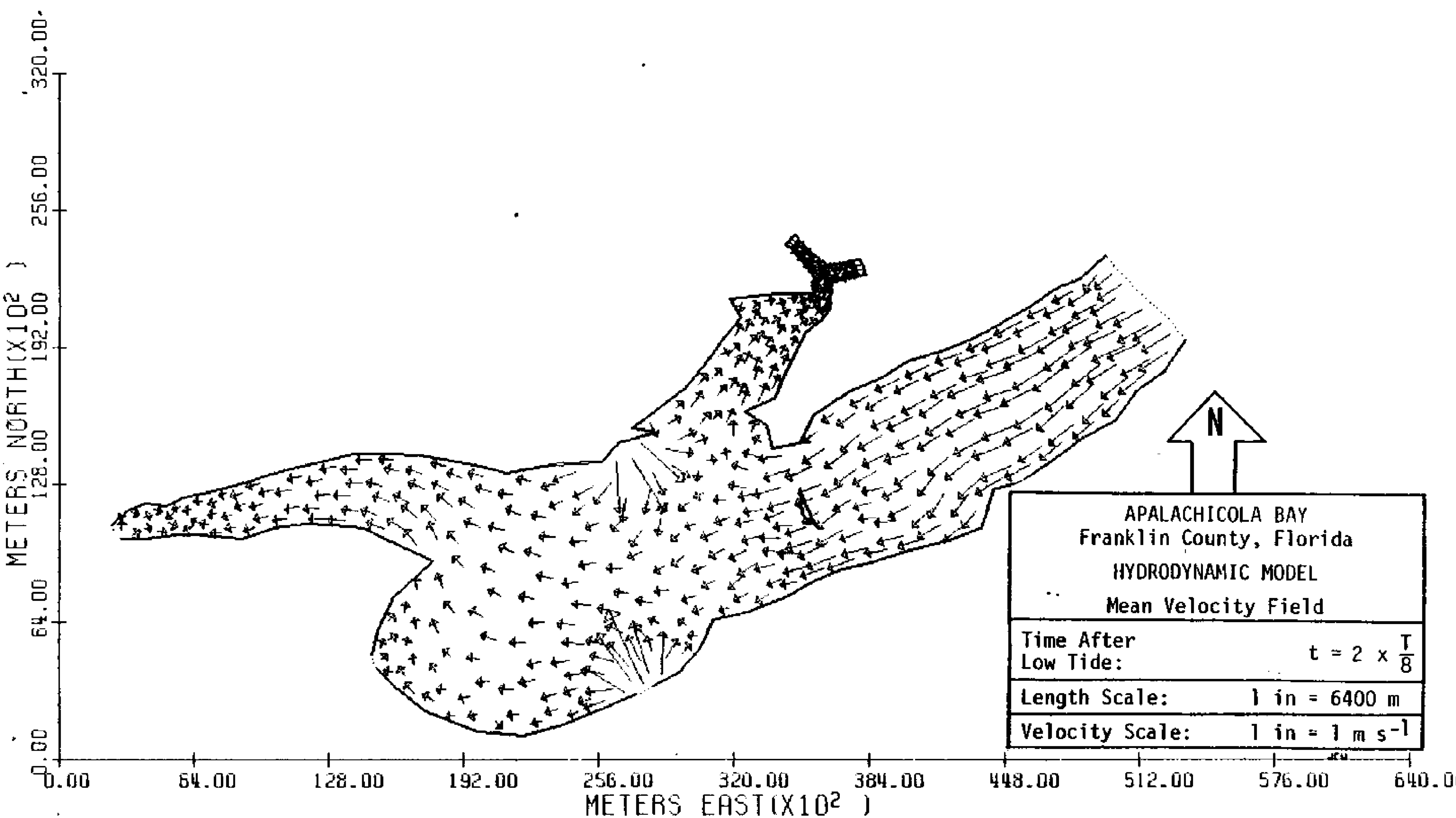

APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 0 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

MAR 1

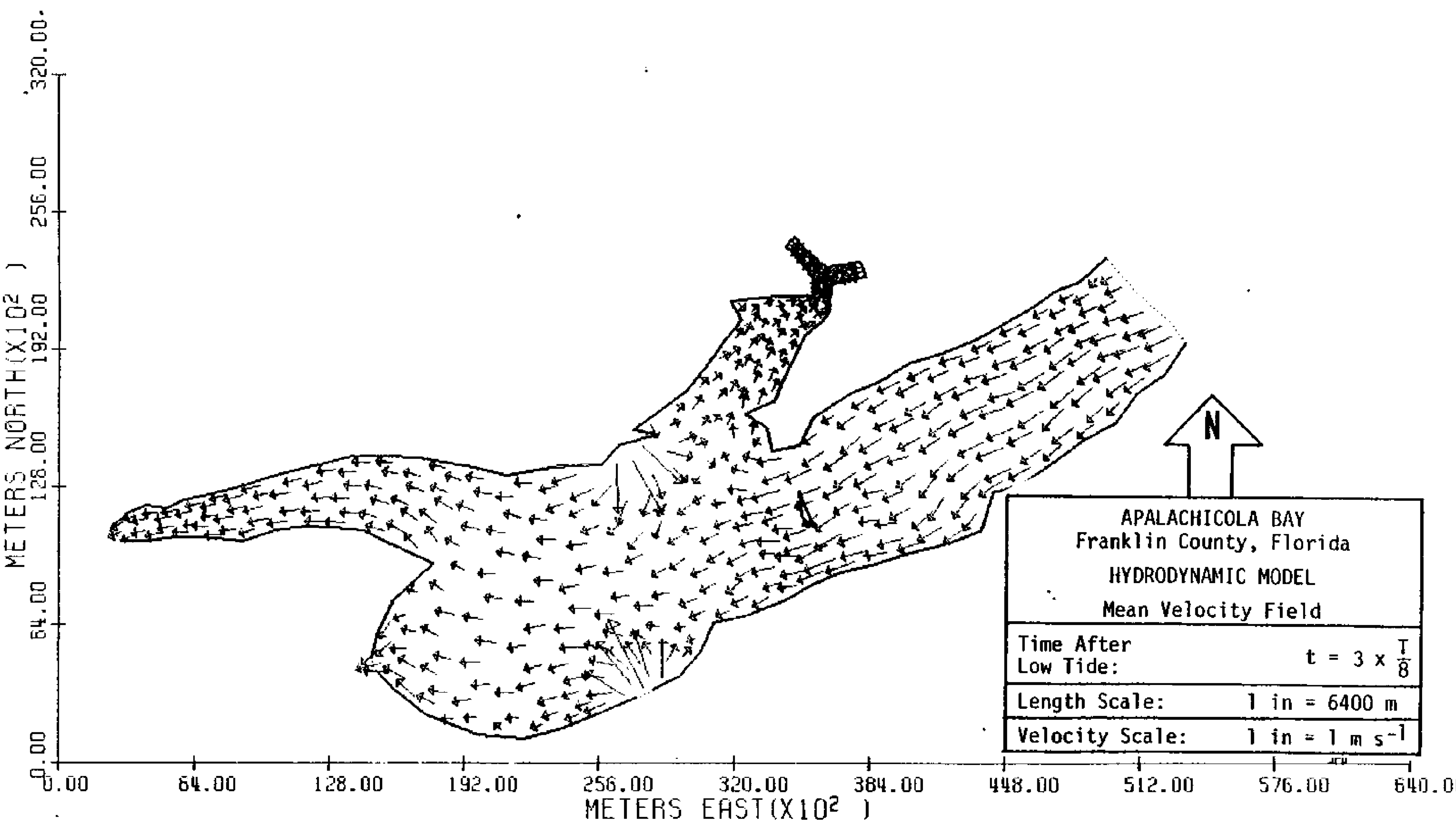


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 1 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

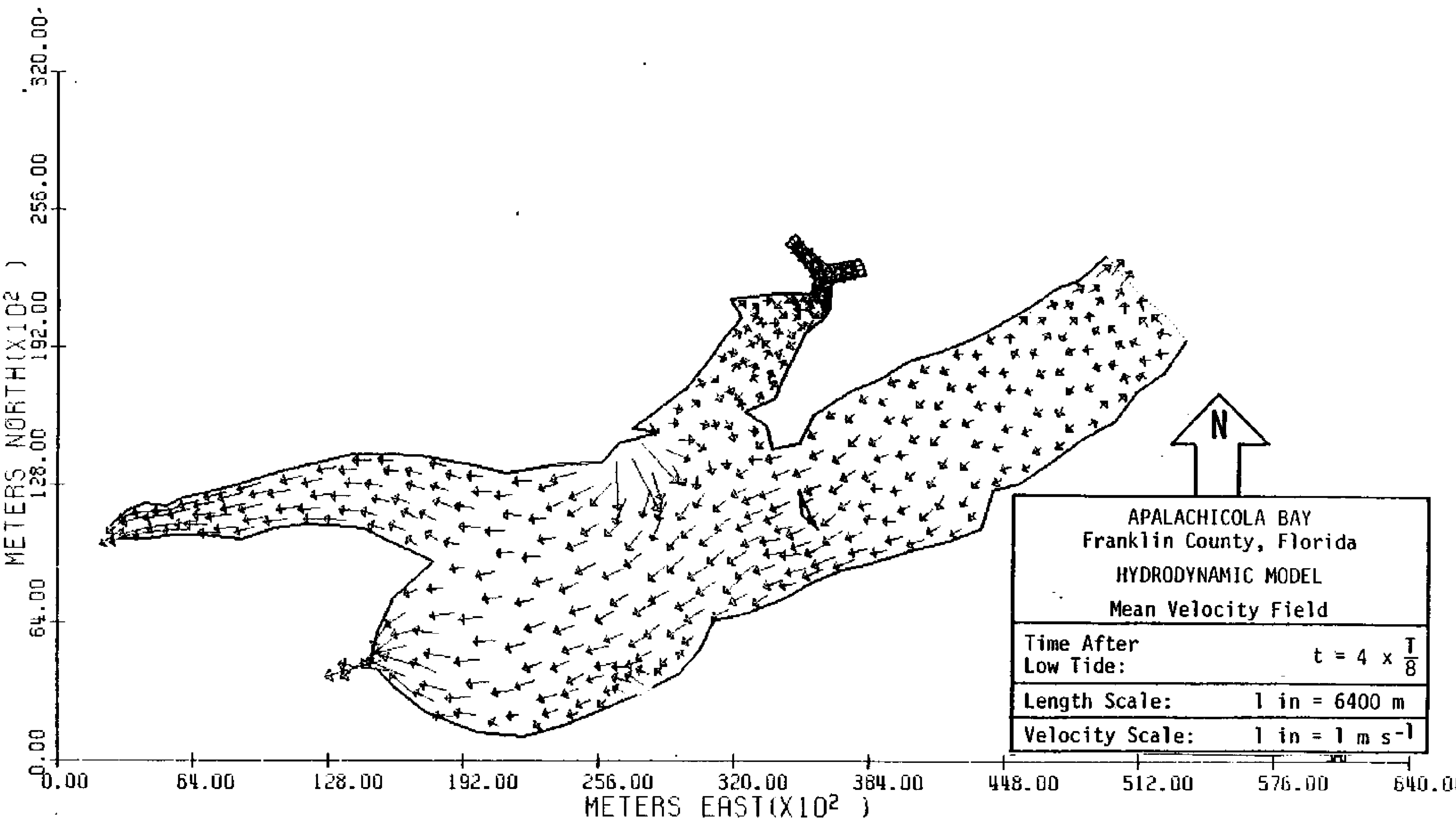
MAR 2


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide:
t = 2 x T/8
Length Scale:
1 in = 6400 m
Velocity Scale:
1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

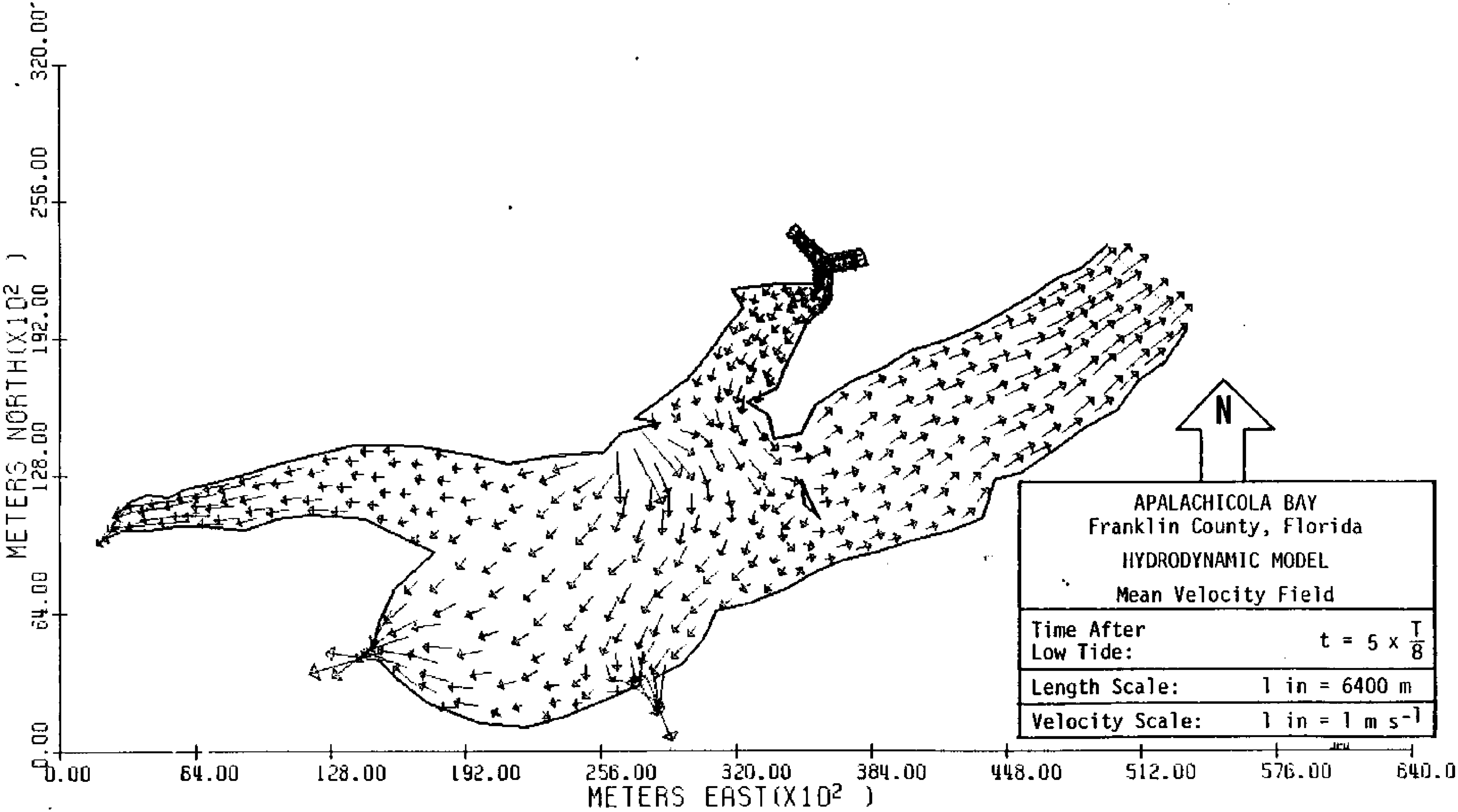
MAR 3


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide:
$t = 3 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

MAR 4

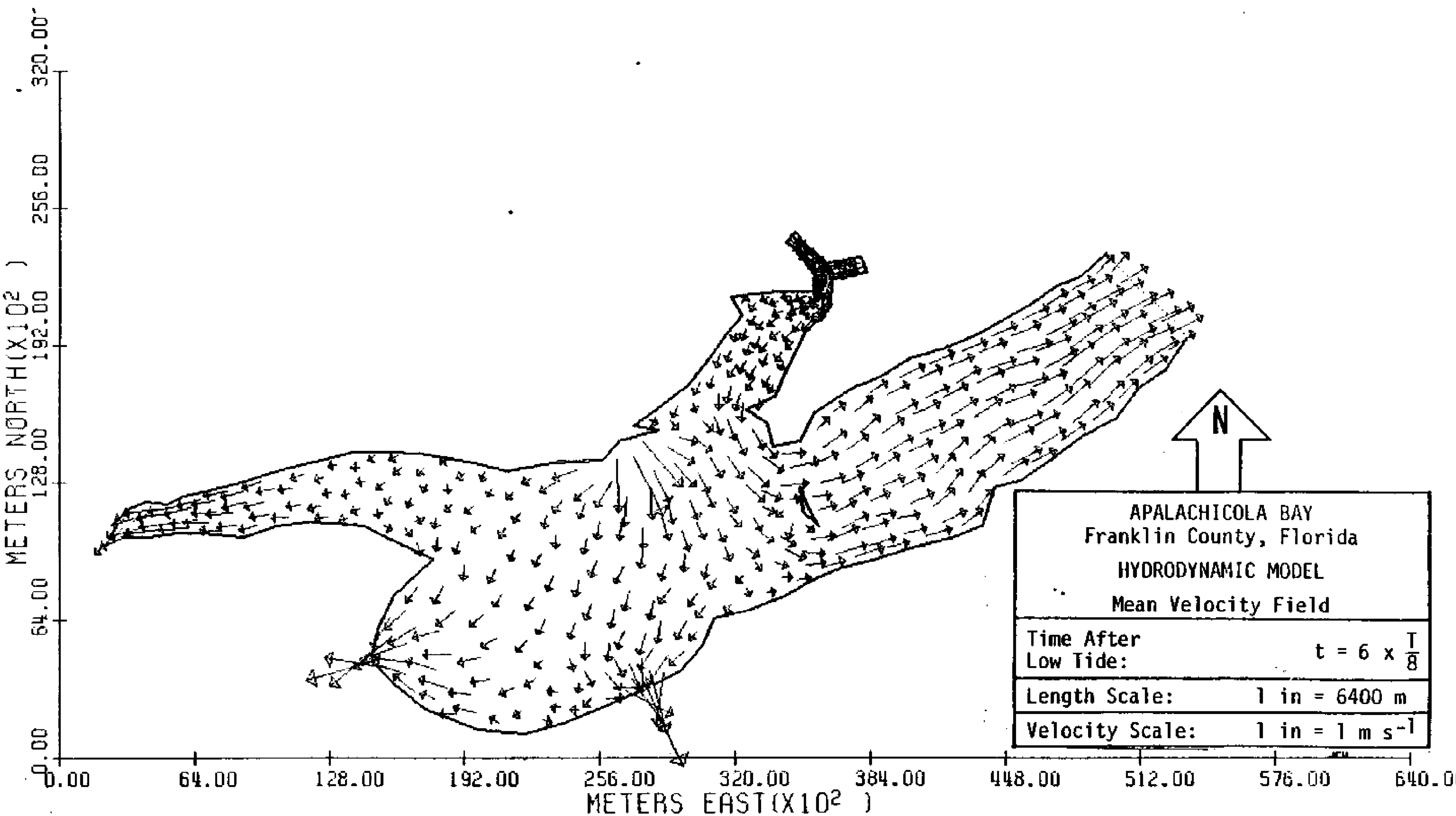

APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 4 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

MAR 5

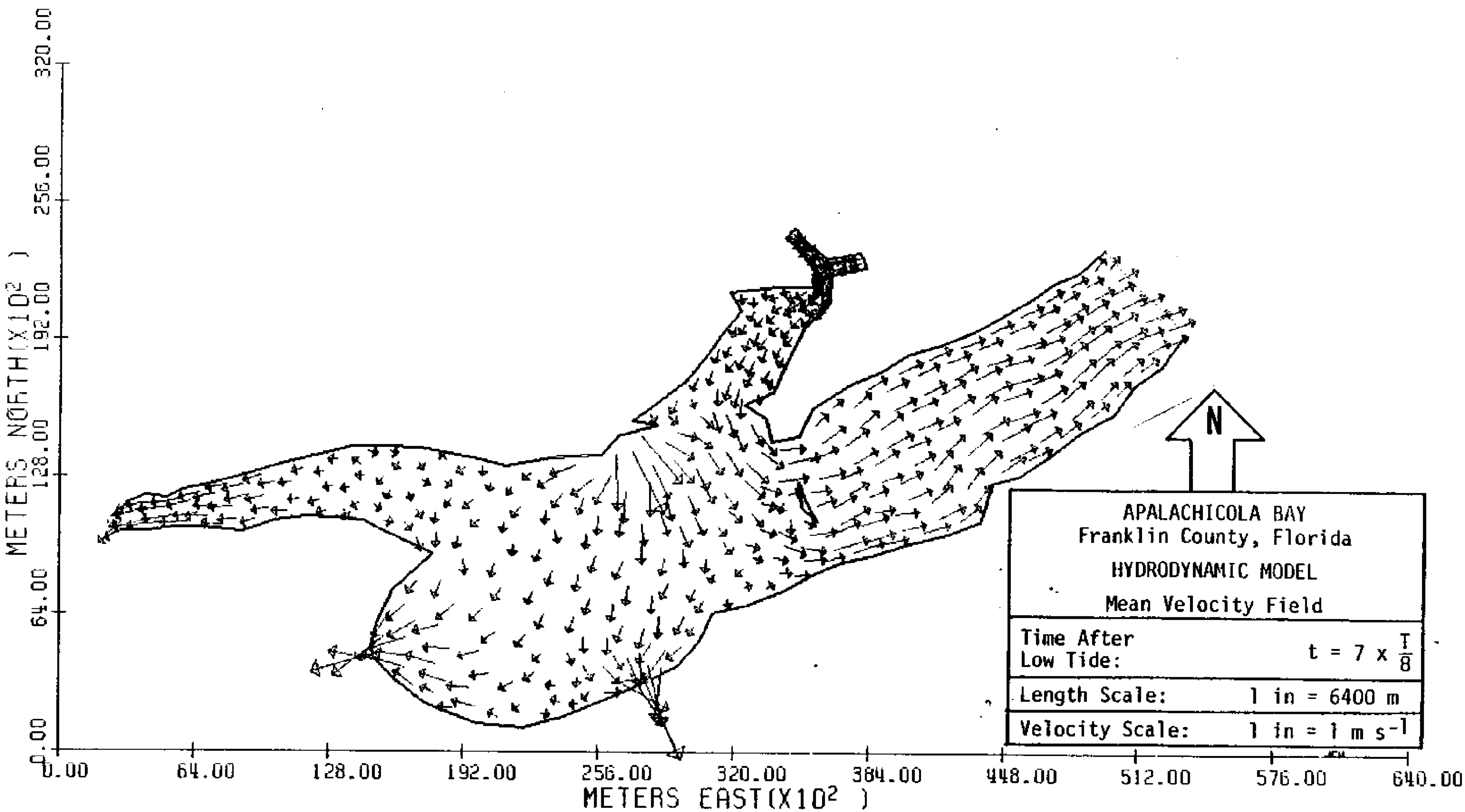


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 5 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

MAR 6

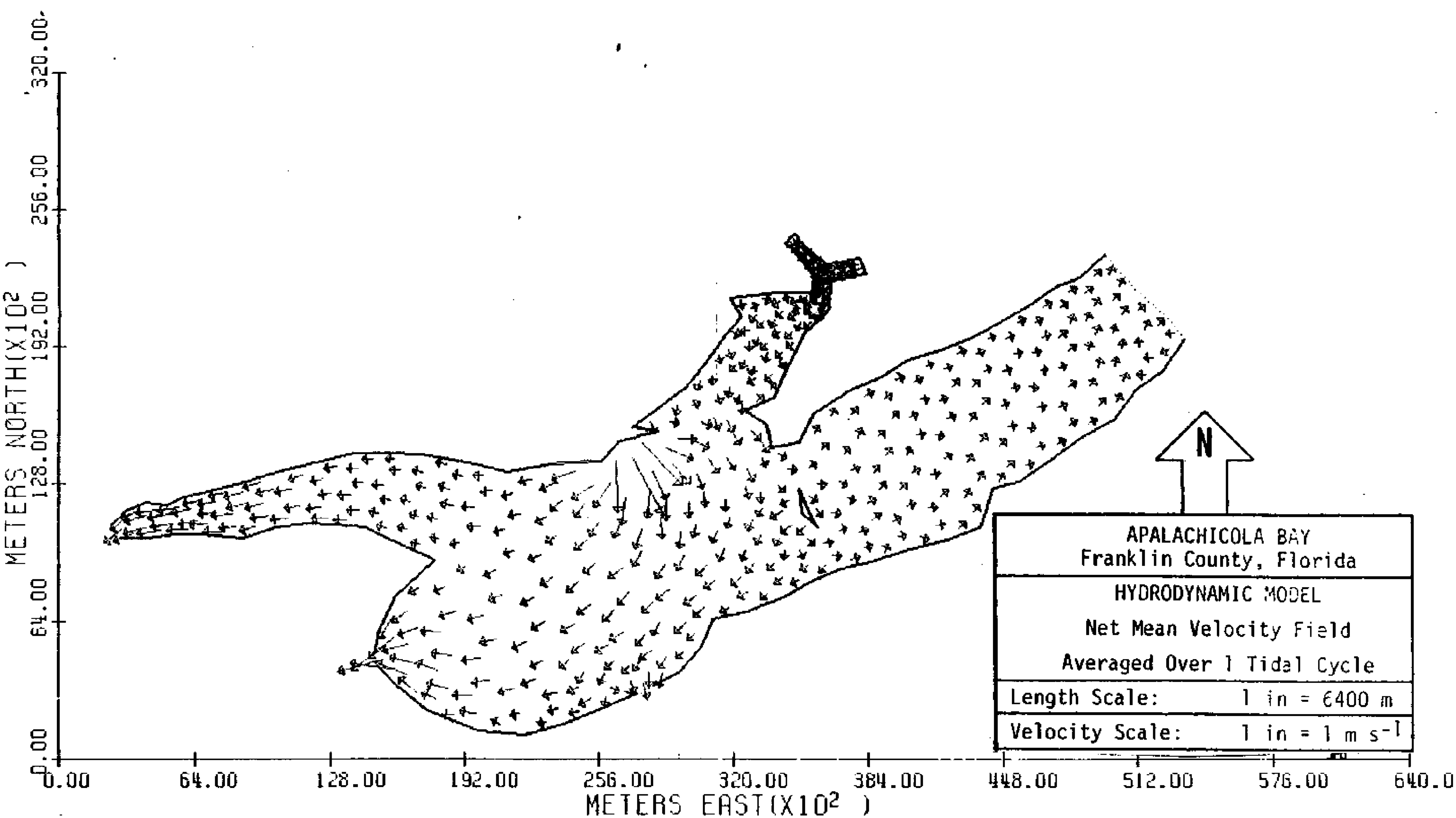

APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 6 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^-1
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

MAR 7



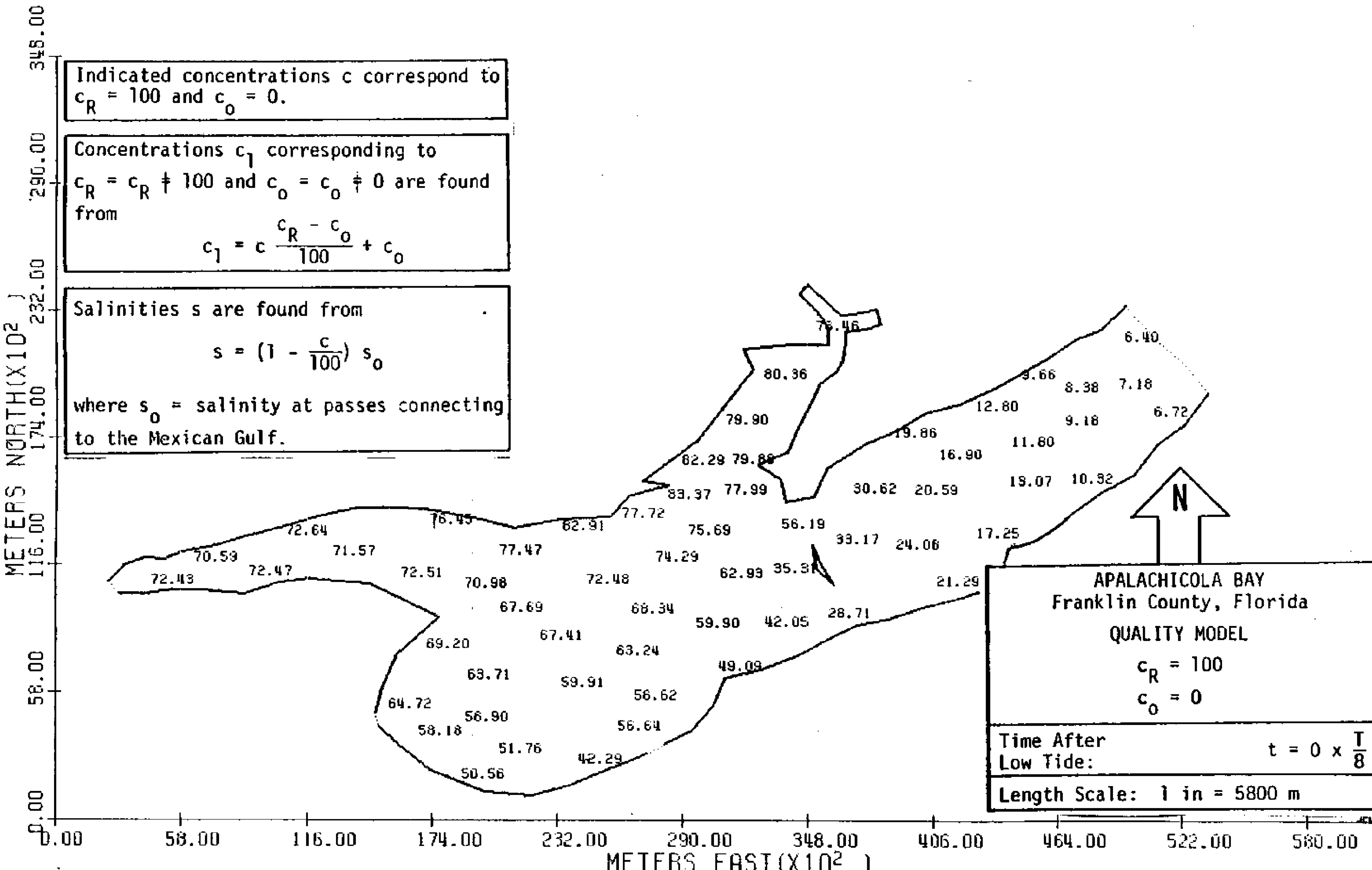
APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 7 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH ($\times 10^2$)
METERS EAST ($\times 10^2$)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

MAR 8

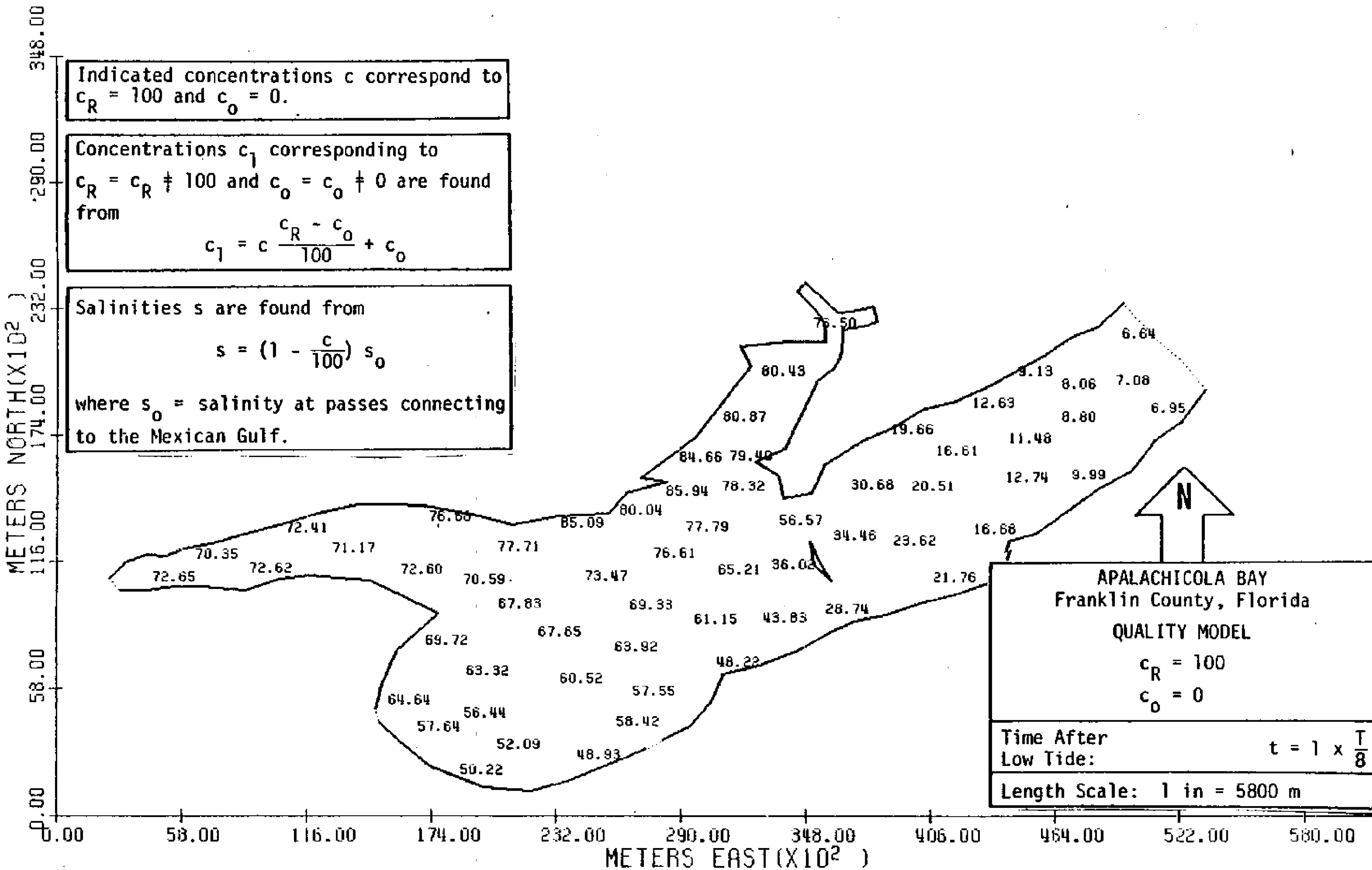


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Net Mean Velocity Field
Averaged Over 1 Tidal Cycle
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

MAR 9

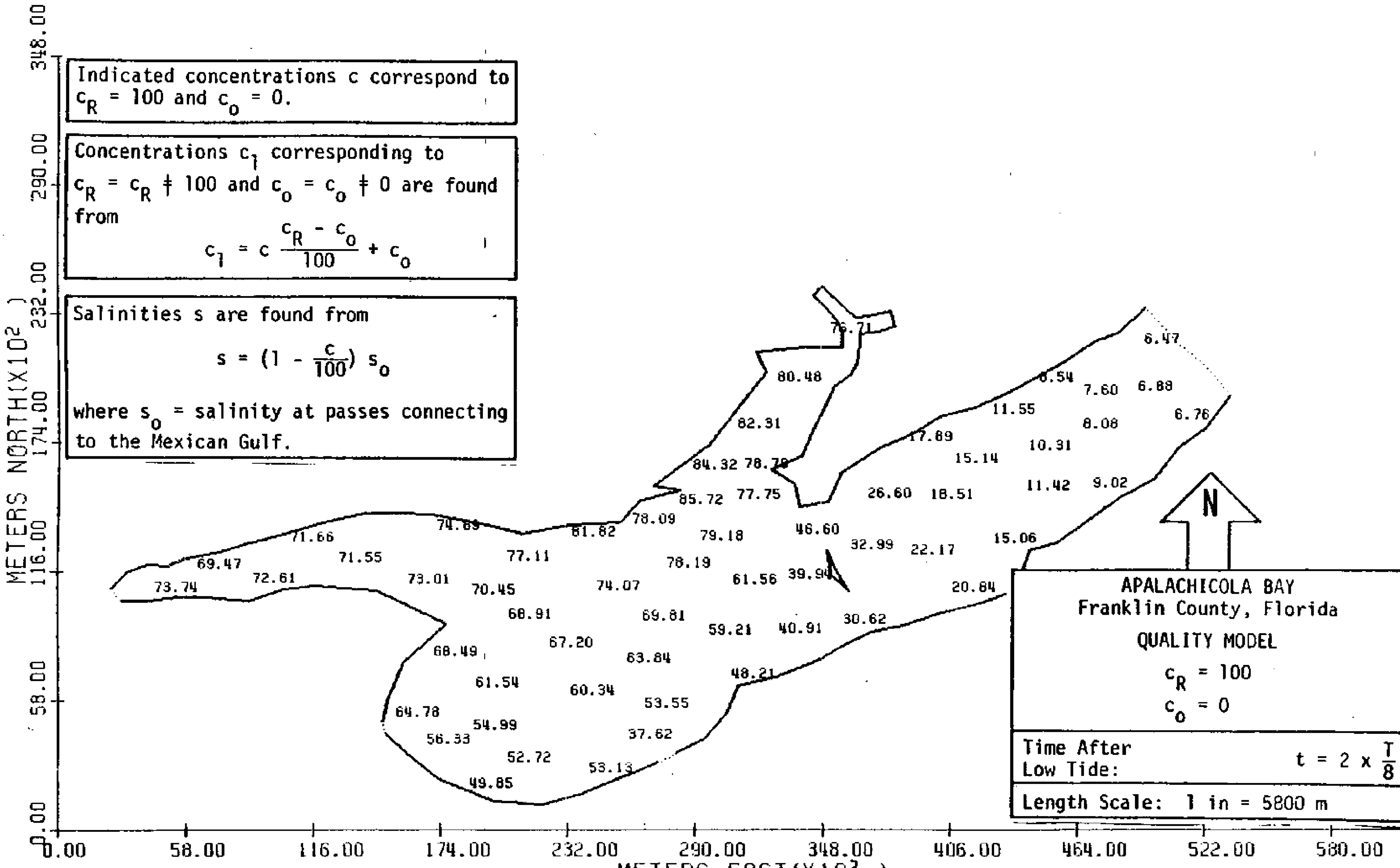

Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 0 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
6.40
8.38
7.18
6.72
12.80
9.18
11.80
16.90
19.07
10.32
30.62
20.59
33.17
24.06
17.25
21.29
80.36
79.90
82.29
83.37
77.99
56.19
35.31
28.71
42.05
59.90
62.93
75.69
74.29
77.72
62.91
72.48
68.34
63.24
49.09
56.62
56.64
42.29
59.91
67.41
77.47
70.98
67.69
72.51
71.57
72.64
70.59
72.47
72.43
69.20
63.71
64.72
58.18
56.90
51.76
50.56

MAR 10

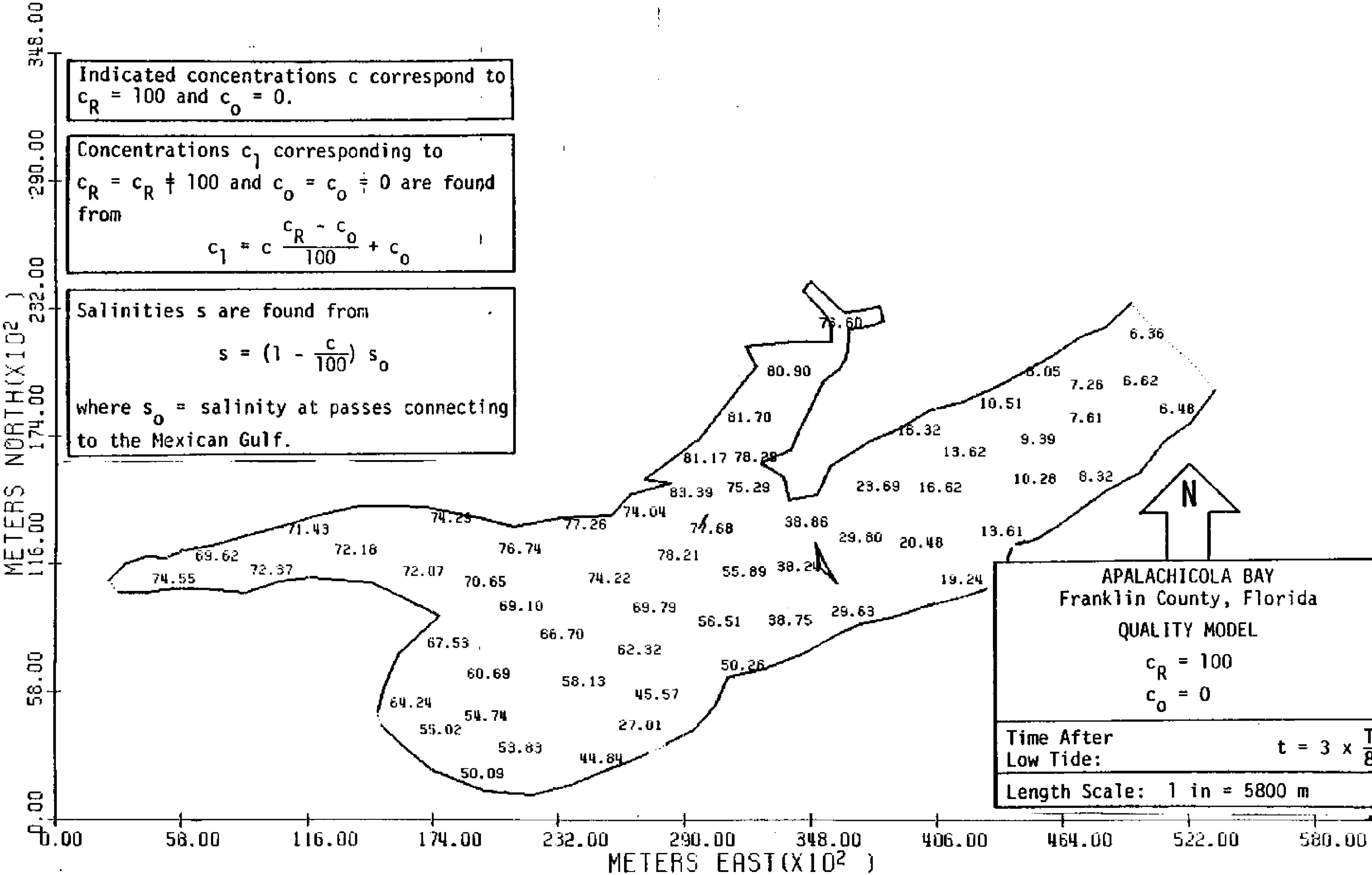


Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c\,\frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = \left(1 - \frac{c}{100}\right) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide: $t = 1 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH($X10^2$)
METERS EAST($X10^2$)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
76.50
80.43
80.87
84.66
79.40
85.94
78.32
80.04
85.09
76.66
72.41
70.35
72.65
72.62
71.17
72.60
77.71
70.59
77.79
76.61
73.47
67.83
69.72
67.65
69.33
63.92
61.15
65.21
56.57
36.02
43.83
28.74
48.22
63.32
60.52
57.55
58.42
64.64
56.44
57.64
52.09
48.93
50.22
34.46
23.62
30.68
20.51
19.66
16.61
12.63
9.13
8.06
7.08
6.64
6.95
8.80
11.48
12.74
9.99
16.68
21.76

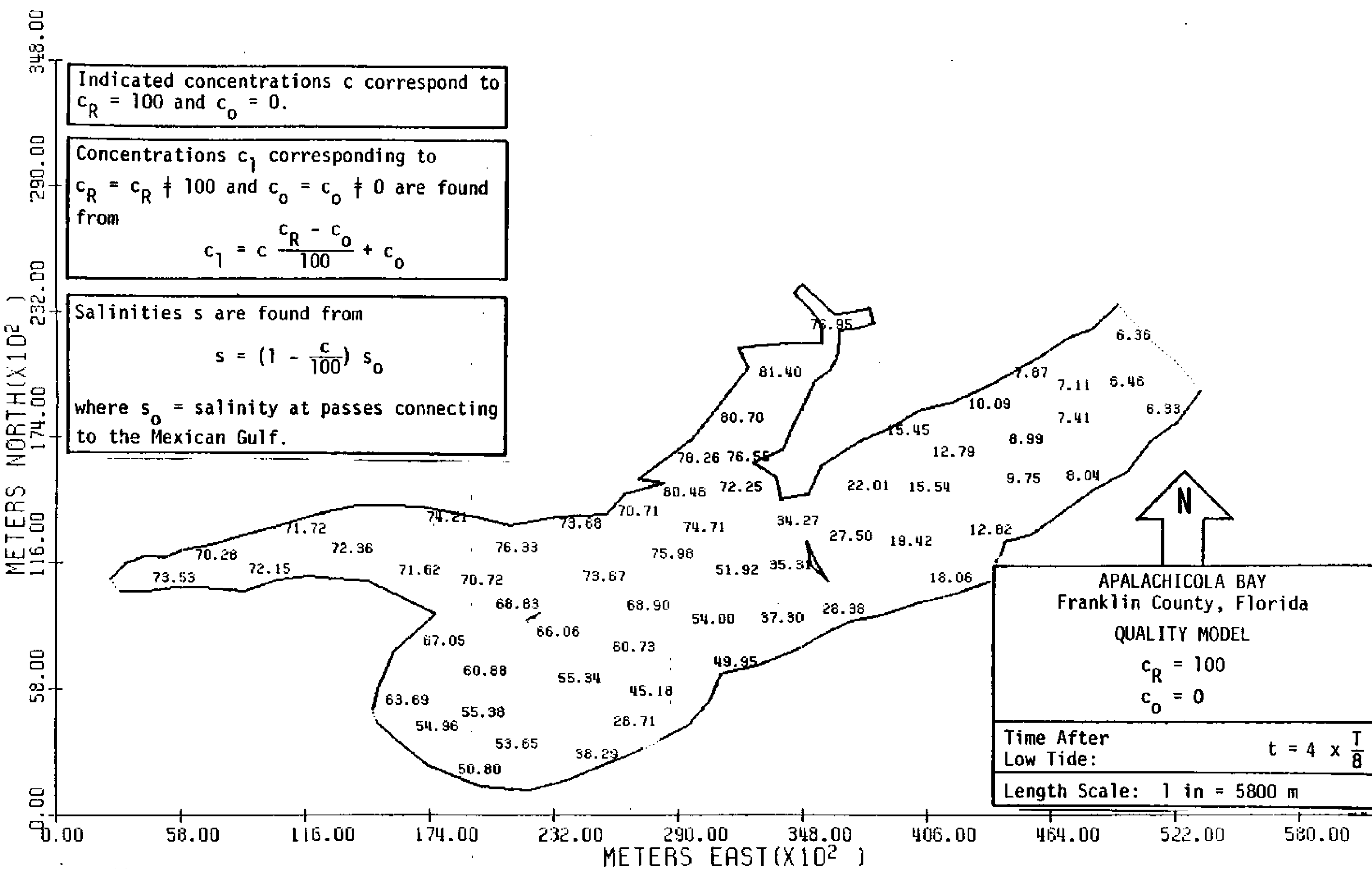
MAR 11


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide: $t = 2 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
6.47
6.54
7.60
6.88
6.76
11.55
8.08
17.89
10.31
15.14
11.42
9.02
26.60
18.51
15.06
32.99
22.17
20.84
76.71
80.48
82.31
84.32
78.78
85.72
77.75
78.09
79.18
46.60
74.89
81.82
77.11
78.19
61.56
39.94
71.66
71.55
69.47
72.61
73.74
73.01
70.45
74.07
68.91
69.81
59.21
40.91
30.62
68.49
67.20
63.84
48.21
61.54
60.34
53.55
64.78
54.99
56.33
37.62
52.72
53.13
49.85

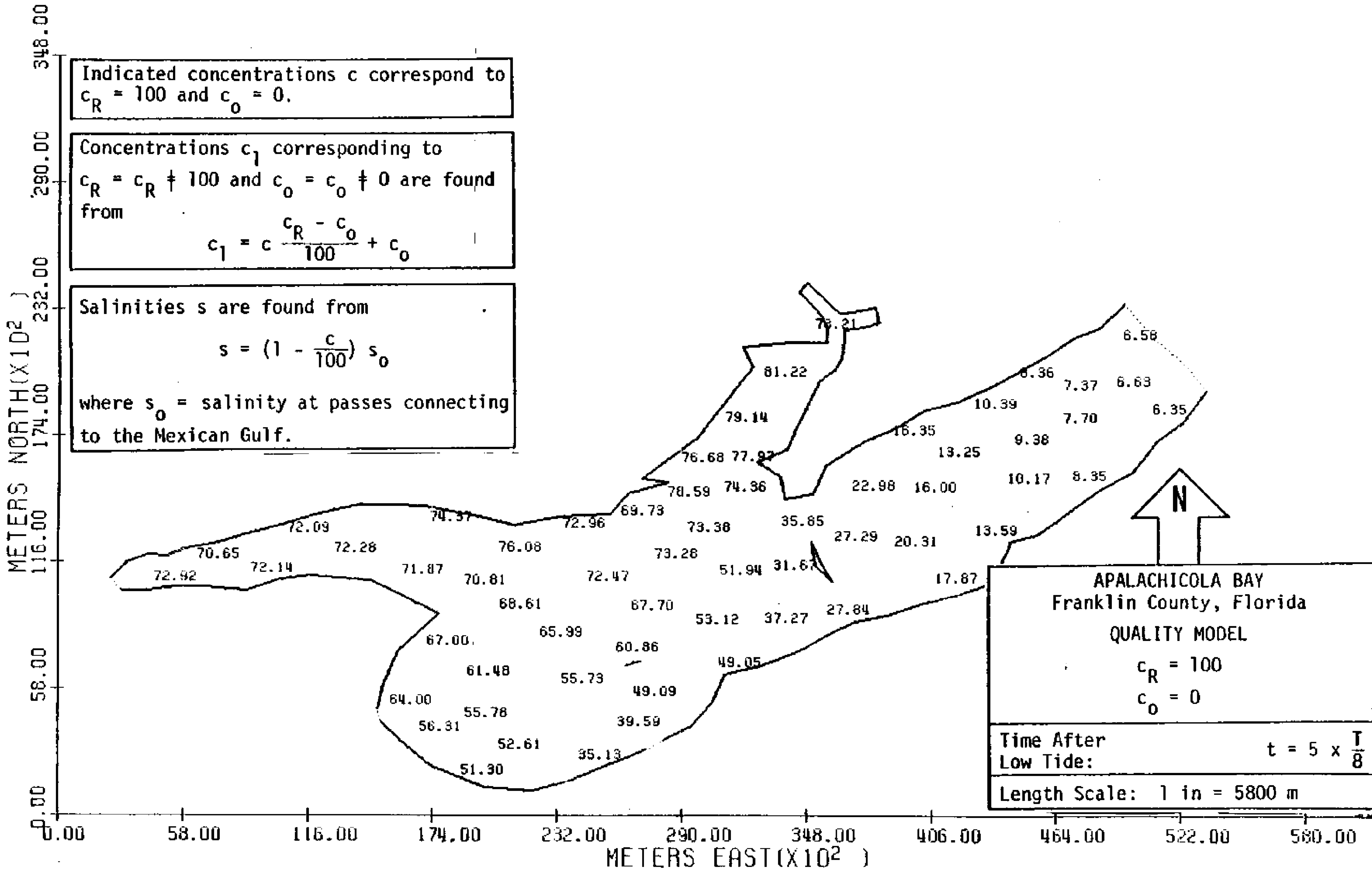
MAR 12


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c\,\frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100})\,s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide: $t = 3 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
6.36
6.05
7.26
6.62
6.48
10.51
7.61
9.39
16.32
13.62
8.32
10.28
23.69
16.62
13.61
38.86
29.80
20.48
19.24
38.24
29.63
55.89
38.75
56.51
50.26
80.90
81.70
81.17
78.28
83.39
75.29
74.04
74.68
78.21
74.22
69.79
62.32
45.57
27.01
44.84
77.26
74.29
76.74
70.65
69.10
66.70
58.13
53.83
50.09
67.53
60.69
54.74
55.02
64.24
72.07
72.18
71.43
72.37
69.62
74.55

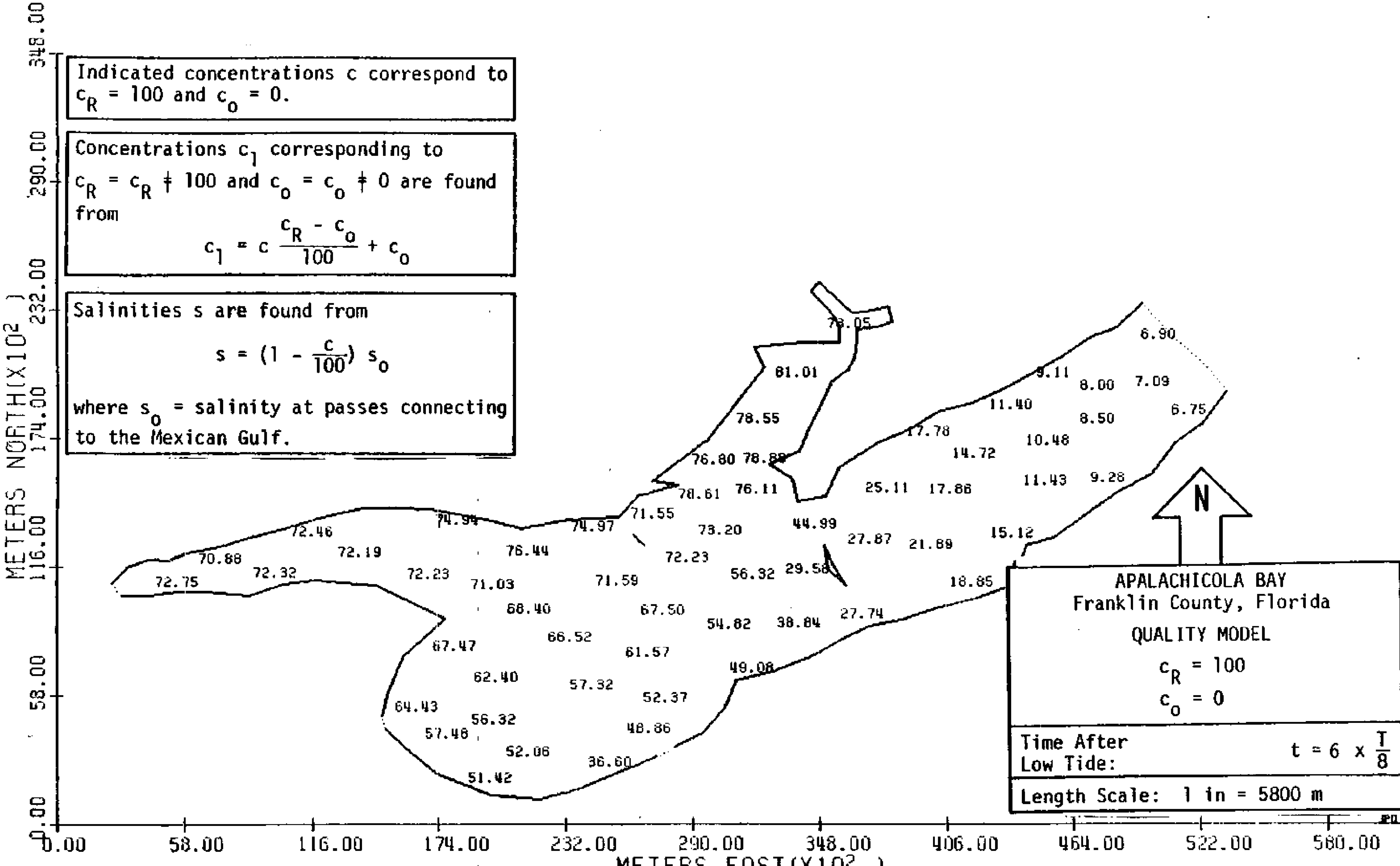
MAR 13


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100})\, s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide: $t = 4 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00

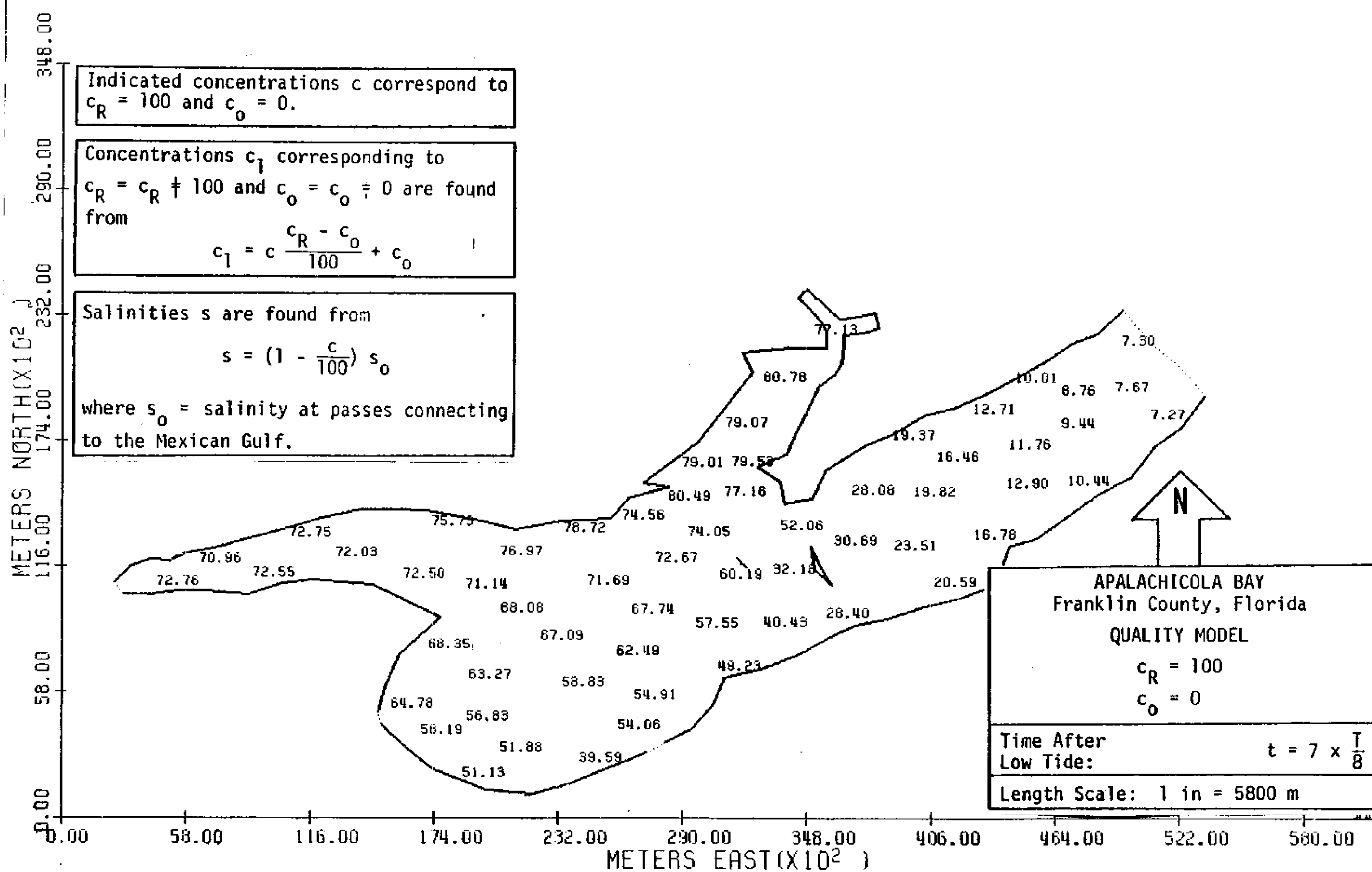
MAR 14


Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c\,\frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = \left(1 - \frac{c}{100}\right) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide: $t = 5 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
81.22
79.14
76.68
77.92
78.59
74.36
69.73
73.38
73.28
35.85
22.98
16.00
16.35
13.25
10.39
9.38
10.17
8.35
7.37
7.70
6.63
6.58
6.35
13.59
20.31
27.29
31.67
51.94
17.87
27.84
37.27
53.12
49.05
72.09
72.28
74.37
72.96
76.08
70.65
72.14
72.92
71.87
70.81
72.47
67.70
68.61
65.99
60.86
67.00
61.48
55.73
49.09
64.00
55.78
56.31
52.61
39.59
35.13
51.30

MAR 15


Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide:
$t = 6 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
72.75
70.88
72.32
72.46
72.19
72.23
74.94
71.03
76.44
68.40
67.47
66.52
62.40
64.43
57.48
56.32
52.06
51.42
36.60
48.86
52.37
57.32
61.57
67.50
71.59
74.97
71.55
72.23
73.20
78.61
76.80
78.55
81.01
78.05
78.88
76.11
56.32
54.82
49.08
38.84
29.58
44.99
27.74
27.87
25.11
21.89
17.86
17.78
14.72
18.85
15.12
11.43
10.48
11.40
9.11
8.00
8.50
9.28
7.09
6.90
6.75

MAR 16

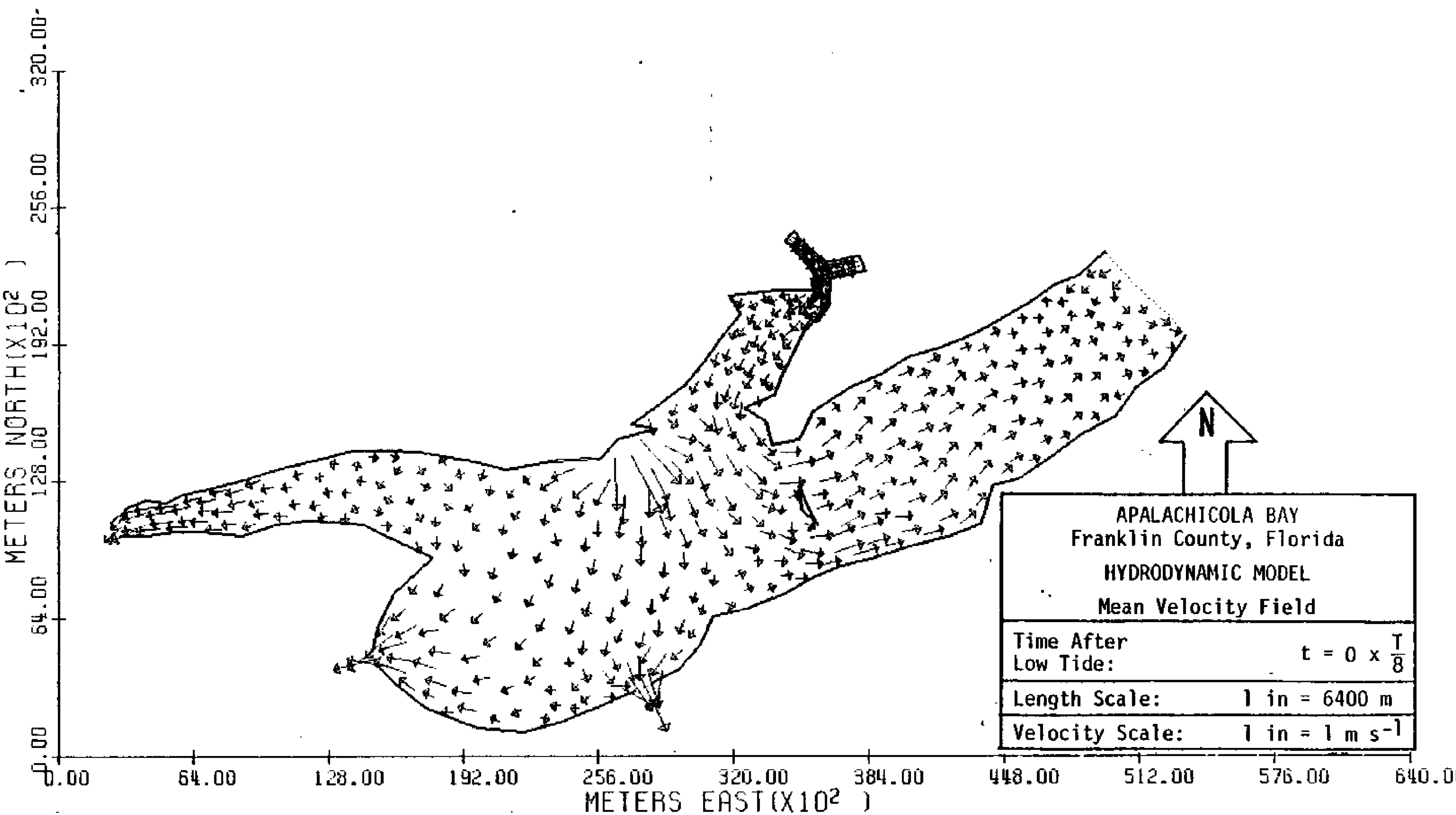


Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_l corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_l = c\,\frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = \left(1 - \frac{c}{100}\right) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide: $t = 7 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
77.13
80.78
79.07
79.01
79.52
80.49
77.16
74.56
75.75
78.72
74.05
52.06
72.75
70.96
72.76
72.55
72.03
72.50
76.97
71.14
71.69
72.67
60.19
32.18
30.69
23.51
28.06
19.82
19.37
16.46
12.71
11.76
10.01
8.76
7.67
7.30
9.44
7.27
12.90
10.44
16.78
20.59
68.08
67.74
57.55
40.43
28.40
68.35
67.09
62.49
48.23
63.27
58.83
54.91
64.78
56.83
56.19
54.06
51.88
39.59
51.13

MAR 17

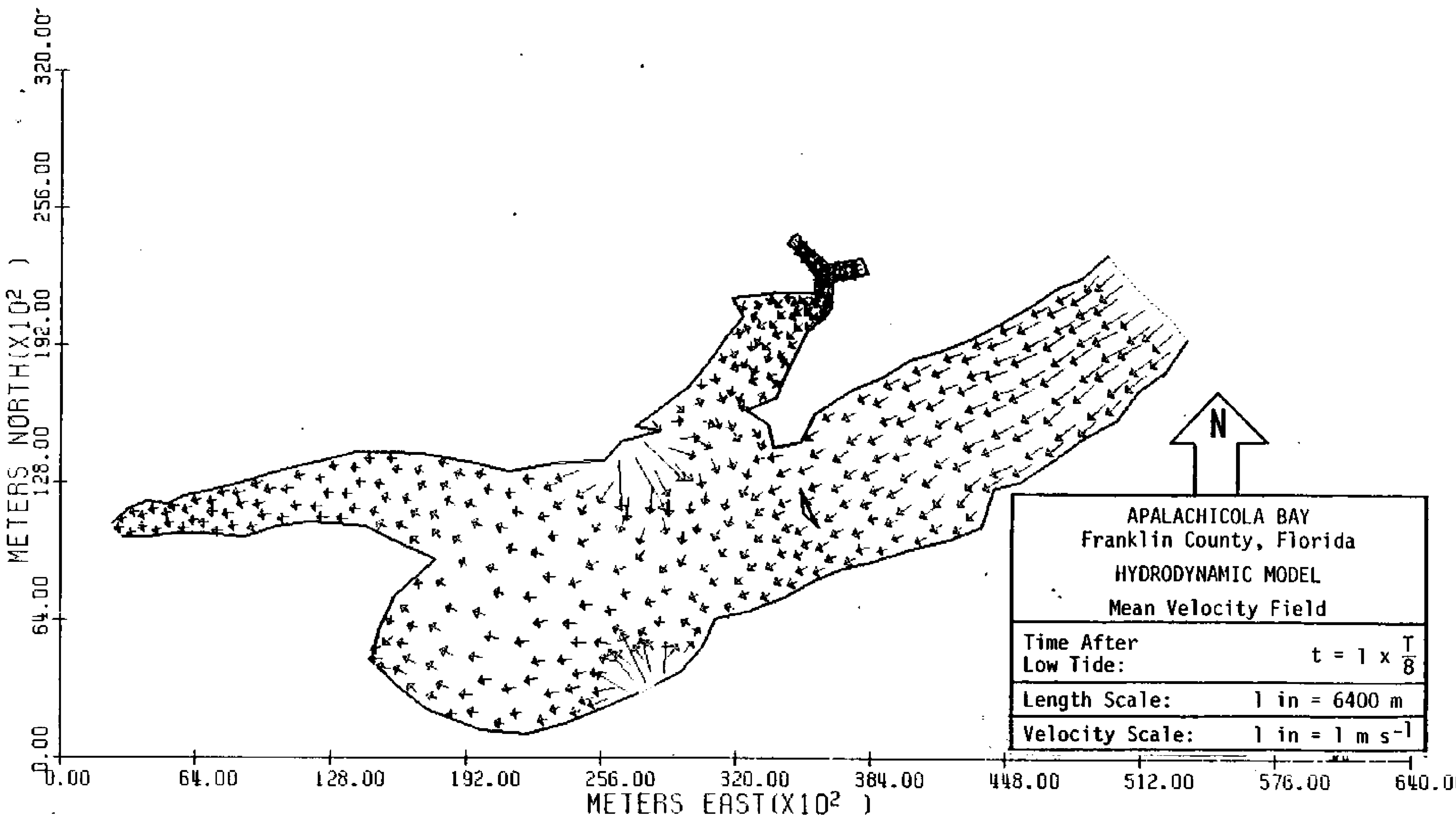
APRIL

APR 1 through APR 8:	Vertically averaged velocities v_m given at time increments equal to one eighth of the tidal period beginning at low tide.
APR 9:	Net values of vertically averaged velocities. Time averaged over one tidal cycle.
APR 10 through APR 17:	Vertically averaged pollutant concentration corresponding to river concentration c_R = 100 and concentration c_o = 0 at all inlets to bay. Concentrations given at time increments equal to one eighth of the tidal period beginning at low tide.

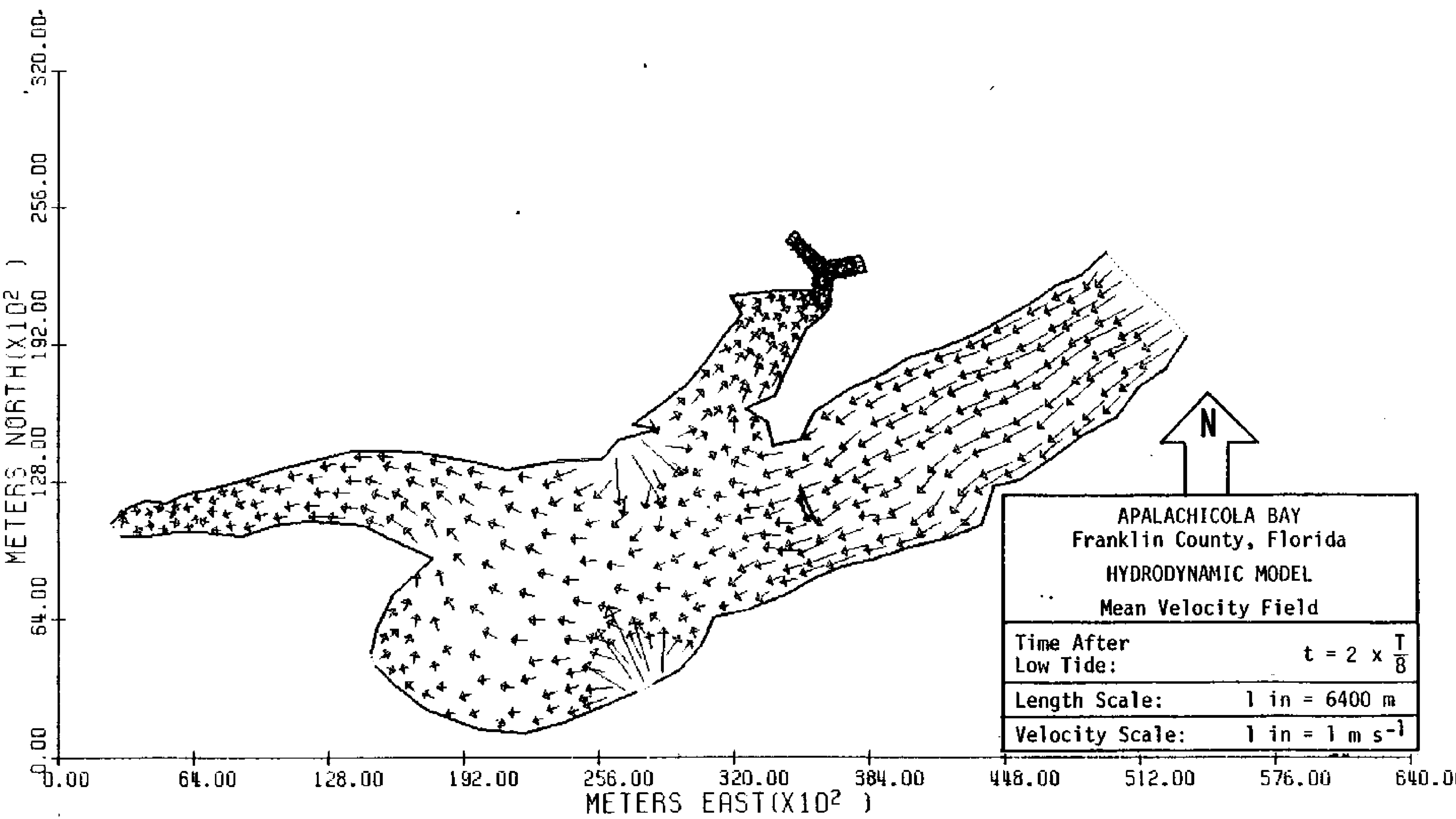


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 0 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

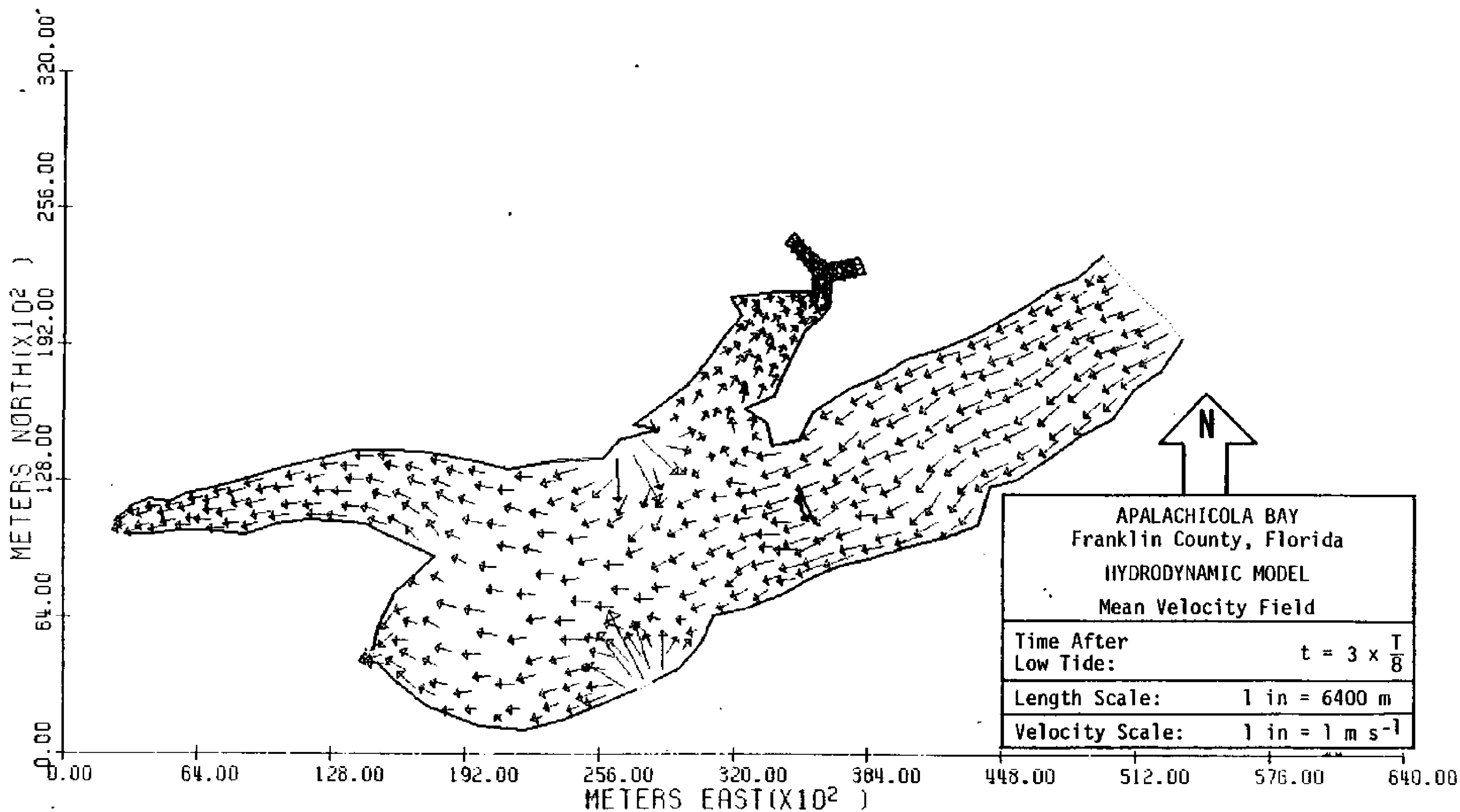
APR 1


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 1 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

APR 2

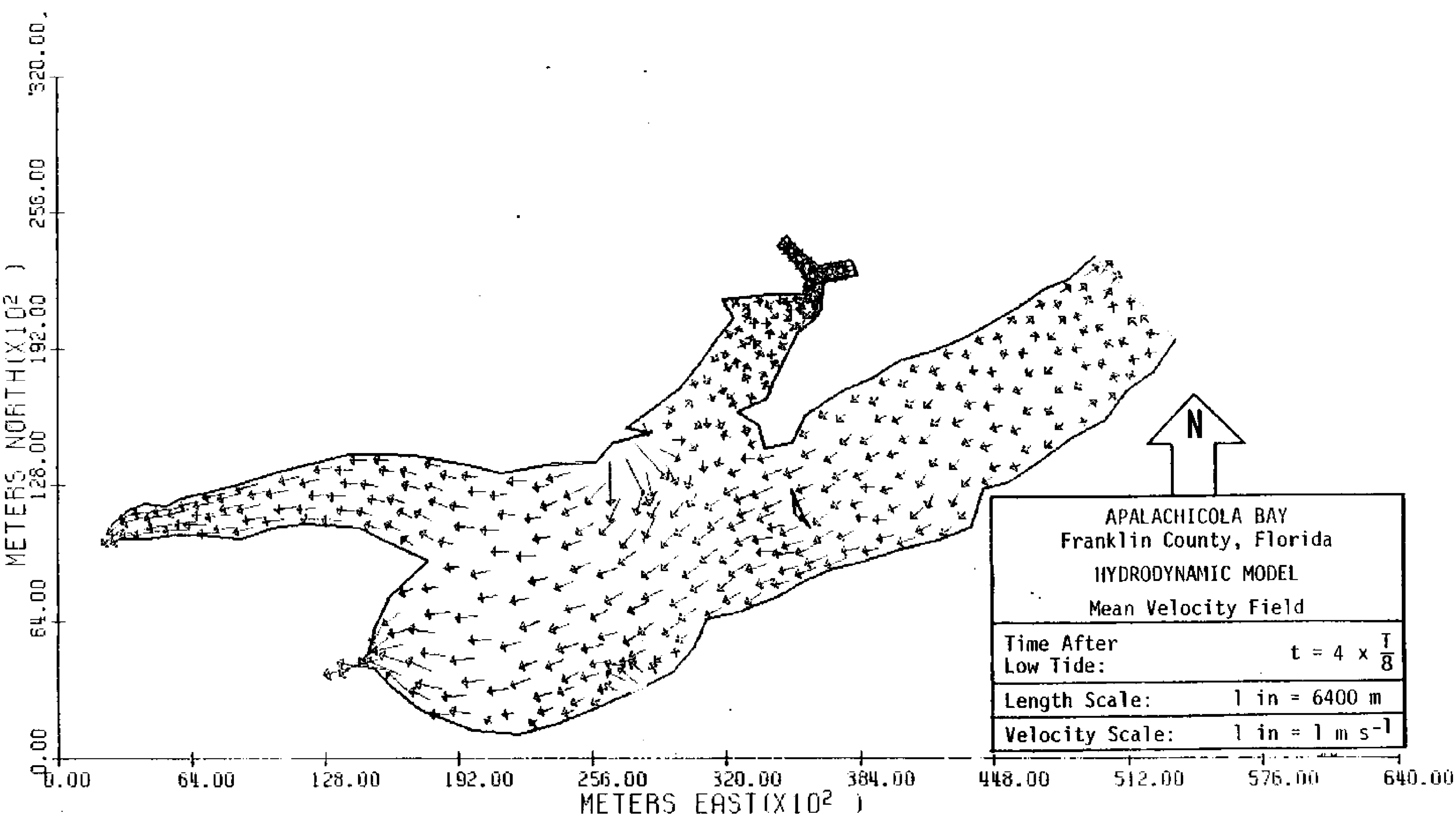

METERS NORTH(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00
METERS EAST(X10²)
N
APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 2 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s⁻¹

APR 3



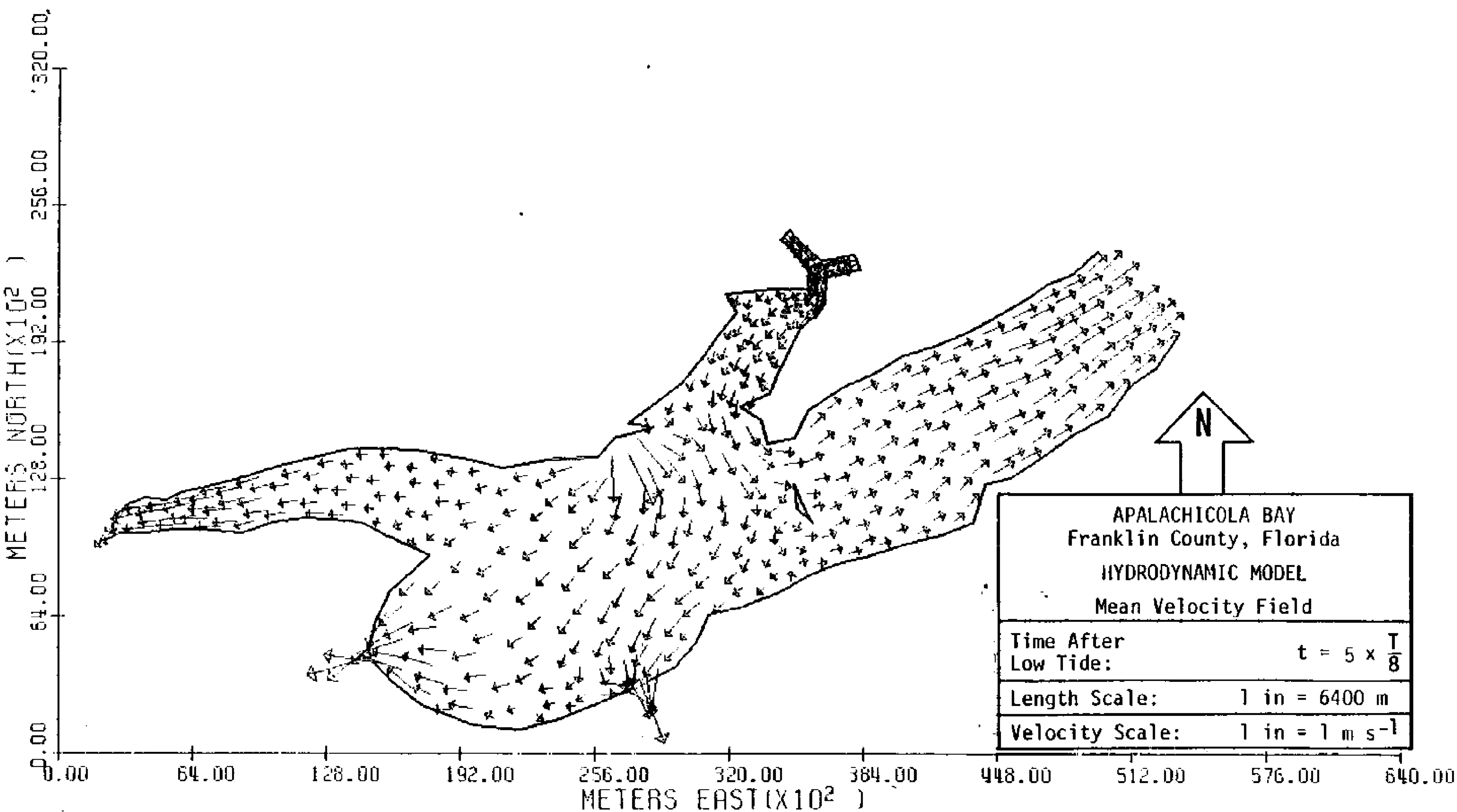
APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 3 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

APR 4



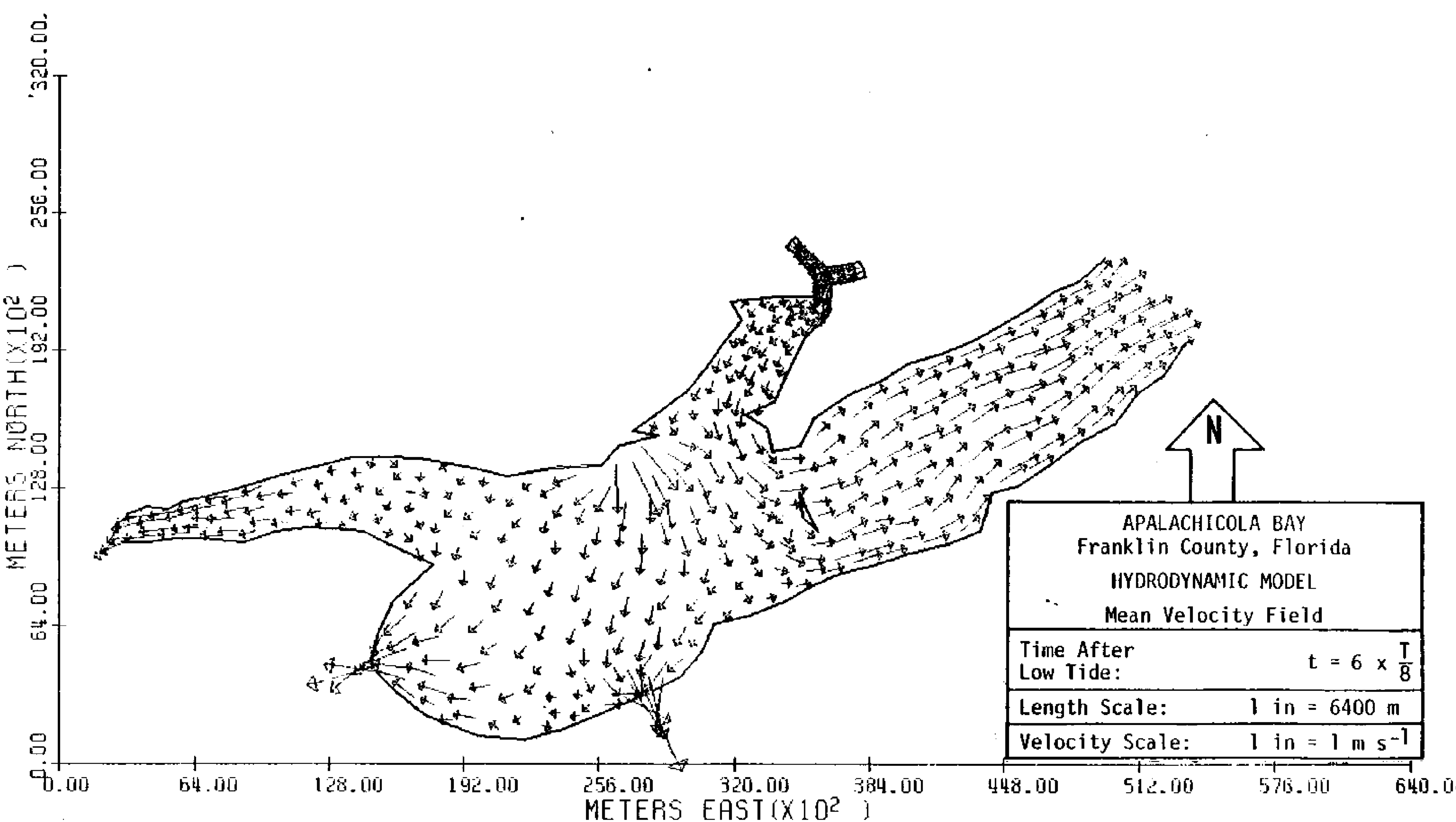
APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 4 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

APR 5



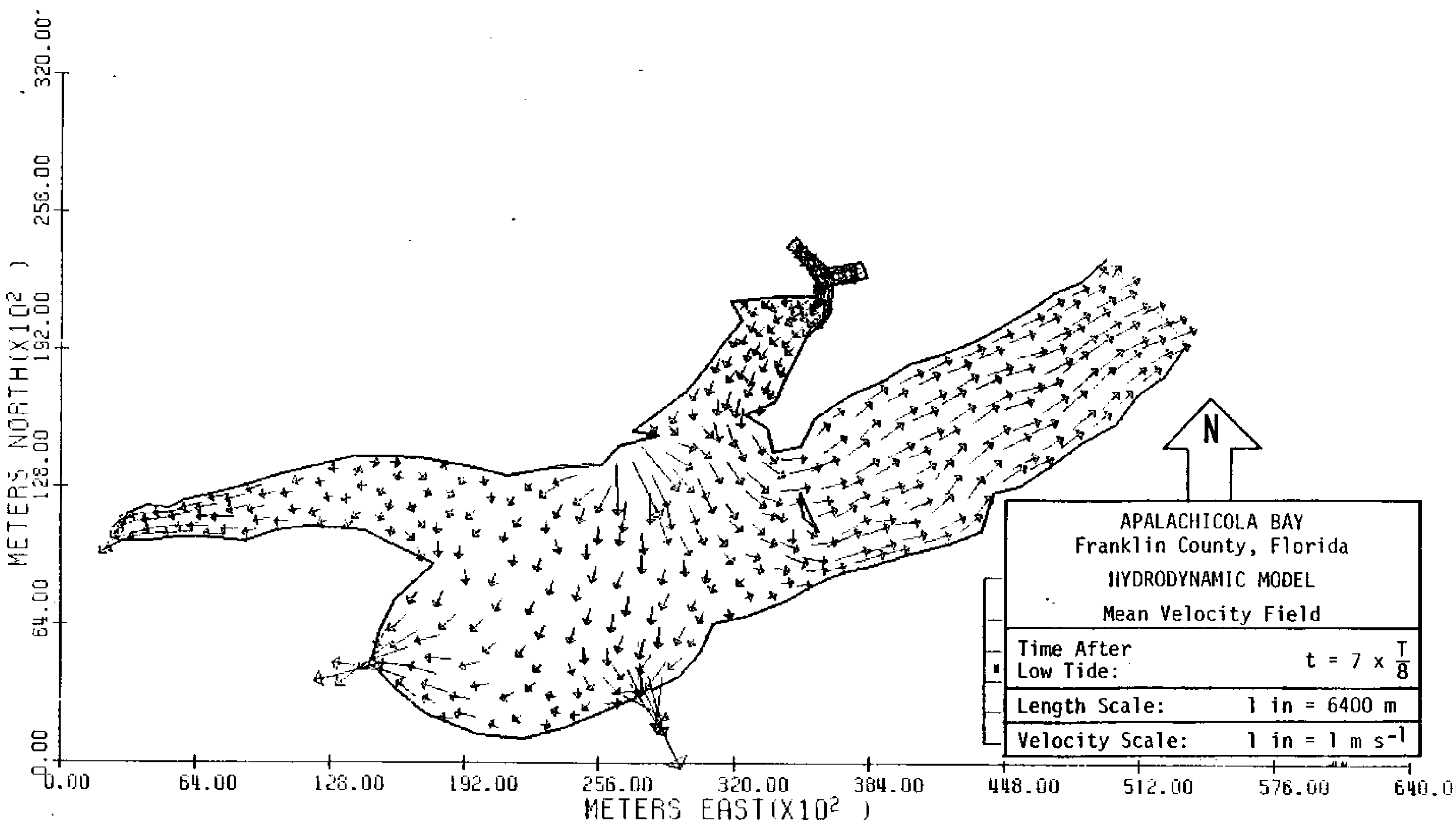
APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 5 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

APR 6

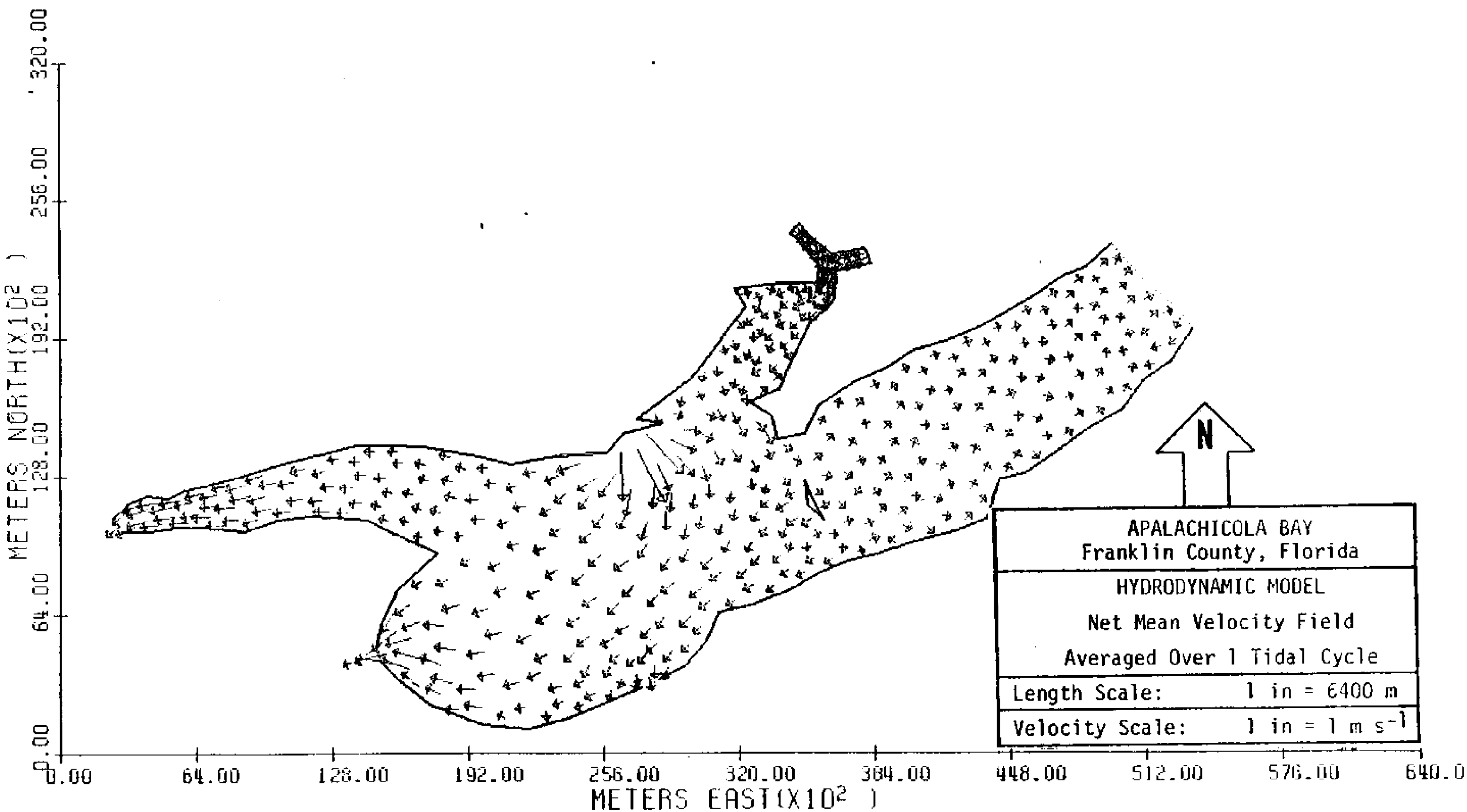


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 6 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

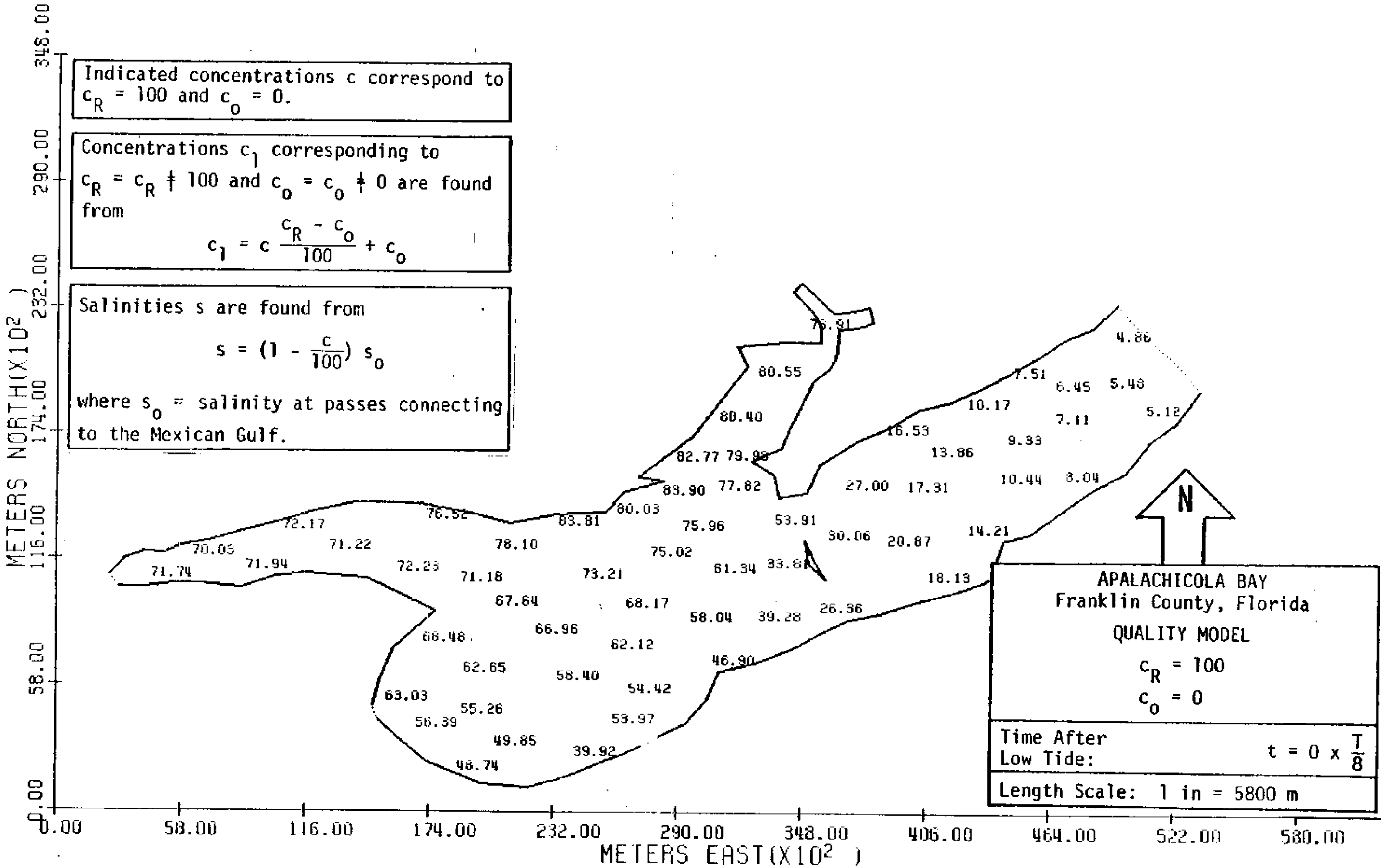
APR 7


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 7 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH($X10^2$)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST($X10^2$)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

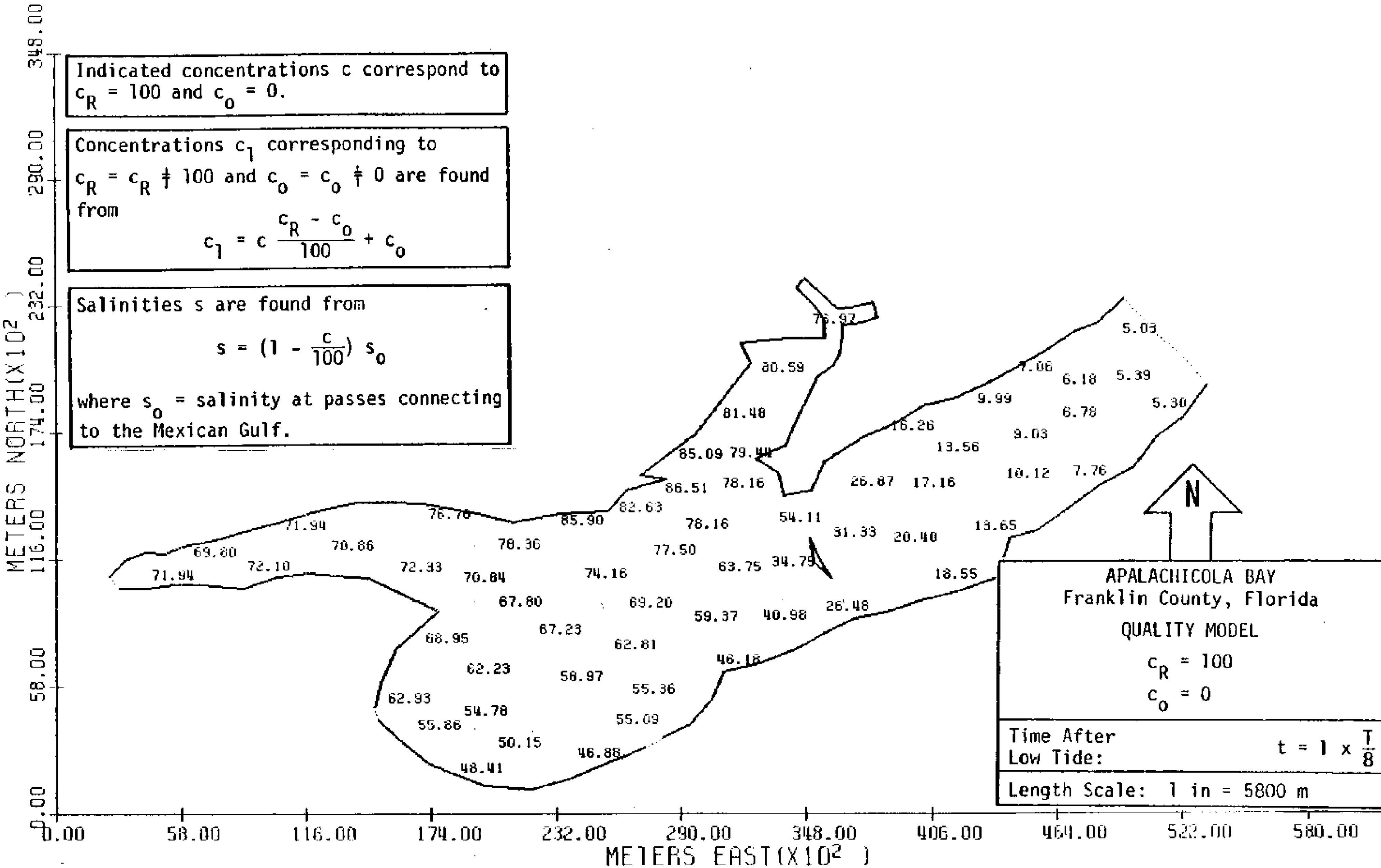
APR 8


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Net Mean Velocity Field
Averaged Over 1 Tidal Cycle
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

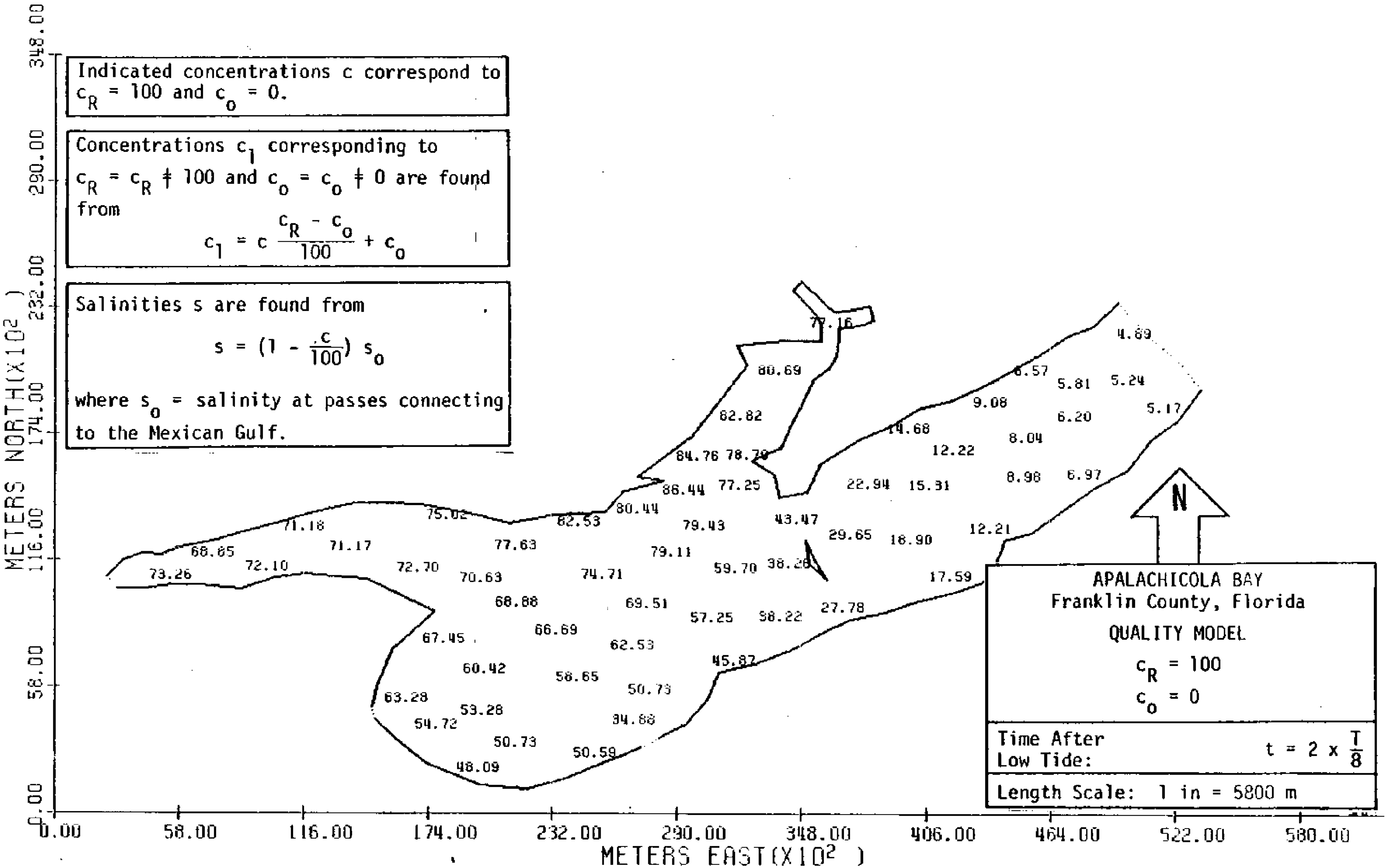
APR 9


Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c \frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = (1 - \frac{c}{100}) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide:
$t = 0 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
4.86
7.51
6.45
5.48
10.17
5.12
7.11
16.53
9.33
13.86
10.44
8.04
27.00
17.31
14.21
53.91
30.06
20.87
18.13
80.55
80.40
82.77
83.90
77.82
80.03
75.96
75.02
61.34
73.21
68.17
58.04
39.28
26.36
72.17
76.52
83.81
70.03
71.22
78.10
71.74
71.94
72.23
71.18
67.64
68.48
66.96
62.12
62.65
58.40
46.90
54.42
63.03
55.26
56.39
53.97
49.85
39.92
48.74

APR 10

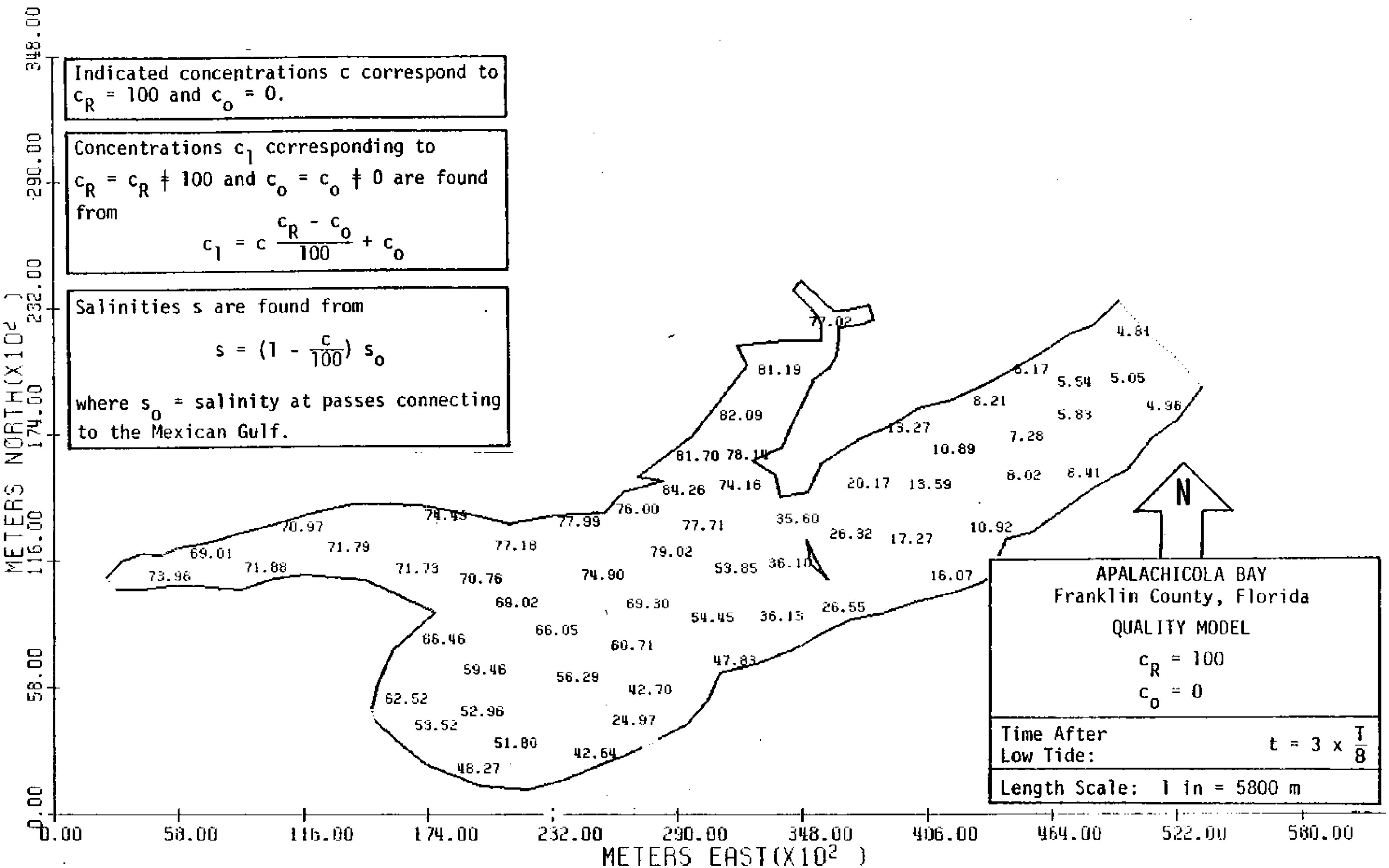

Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c \frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = (1 - \frac{c}{100})\, s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 1 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
5.03
7.06
6.18
5.39
5.30
9.99
6.78
9.03
16.26
13.56
10.12
7.76
80.59
81.48
85.09
79.44
86.51
78.16
26.87
17.16
82.63
85.90
76.76
71.94
69.80
71.94
72.10
70.86
78.36
54.11
31.33
20.40
13.65
78.16
77.50
63.75
34.75
18.55
72.33
70.84
74.16
67.80
69.20
59.37
40.98
26.48
68.95
67.23
62.81
62.23
58.97
46.18
55.36
62.93
54.78
55.86
55.09
50.15
46.88
48.41

APR 11

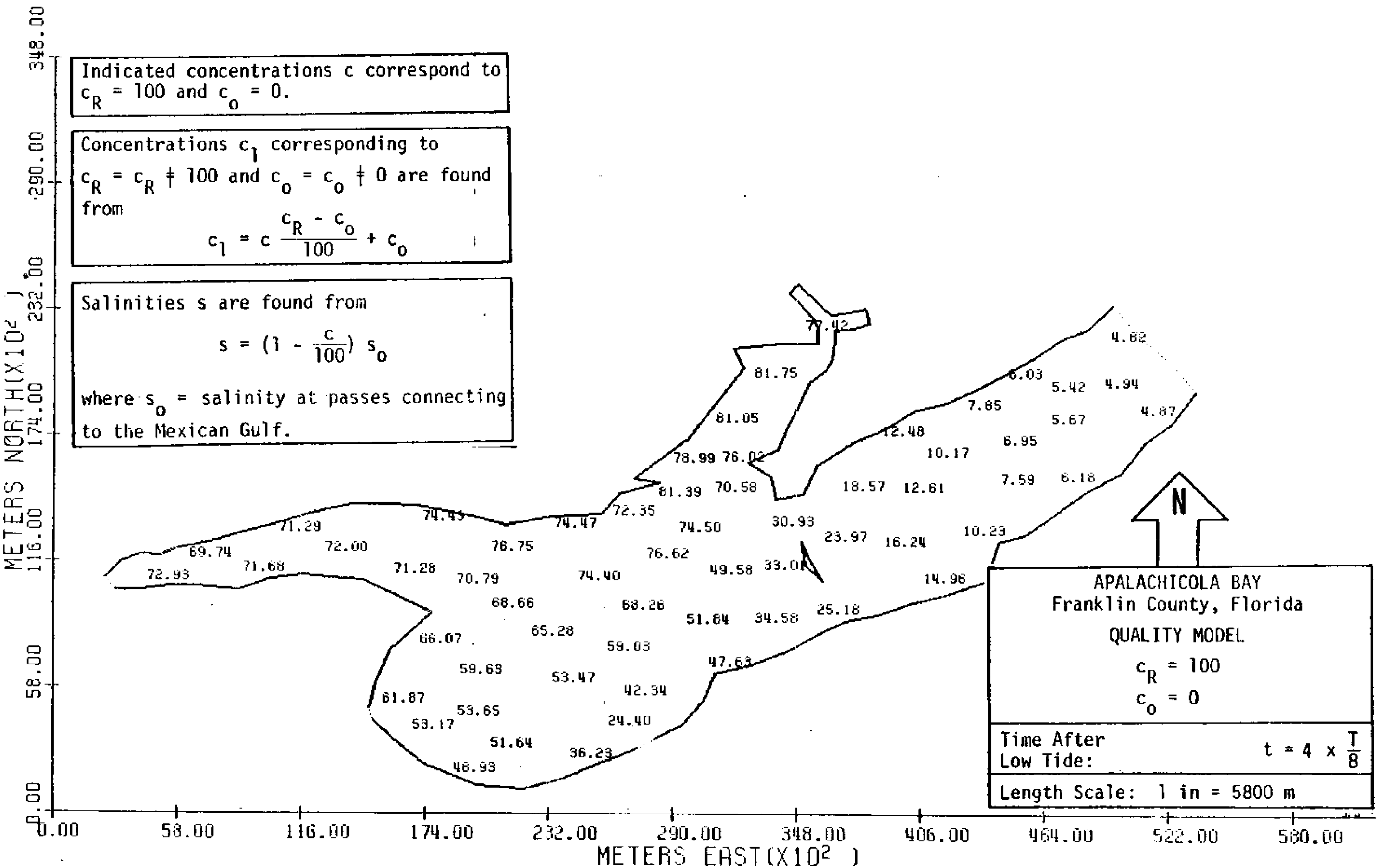


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100})\, s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 2 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00

APR 12

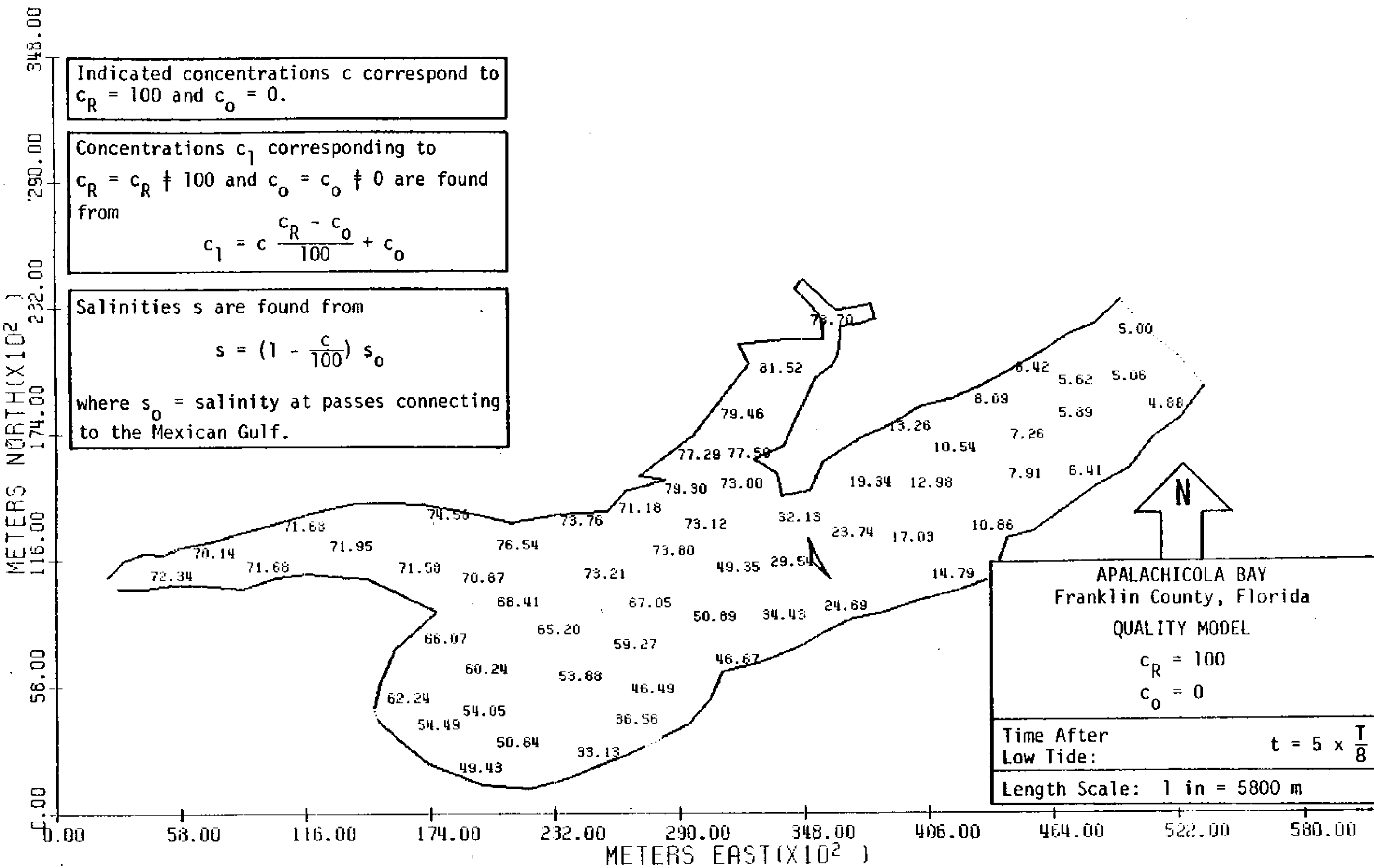

Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c\,\frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = \left(1 - \frac{c}{100}\right) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide: $t = 3 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
73.96
69.01
71.88
70.97
71.79
74.45
71.73
70.76
77.18
77.99
68.02
66.46
59.46
62.52
53.52
52.96
51.80
48.27
66.05
56.29
42.64
74.90
69.30
60.71
42.70
24.97
76.00
79.02
77.71
84.26
74.16
81.70
78.14
82.09
81.19
77.02
53.85
54.45
47.83
36.15
36.10
35.60
26.32
26.55
20.17
13.59
17.27
16.07
10.92
13.27
10.89
8.21
7.28
8.02
8.41
8.17
5.54
5.83
5.05
4.81
4.96

APR 13

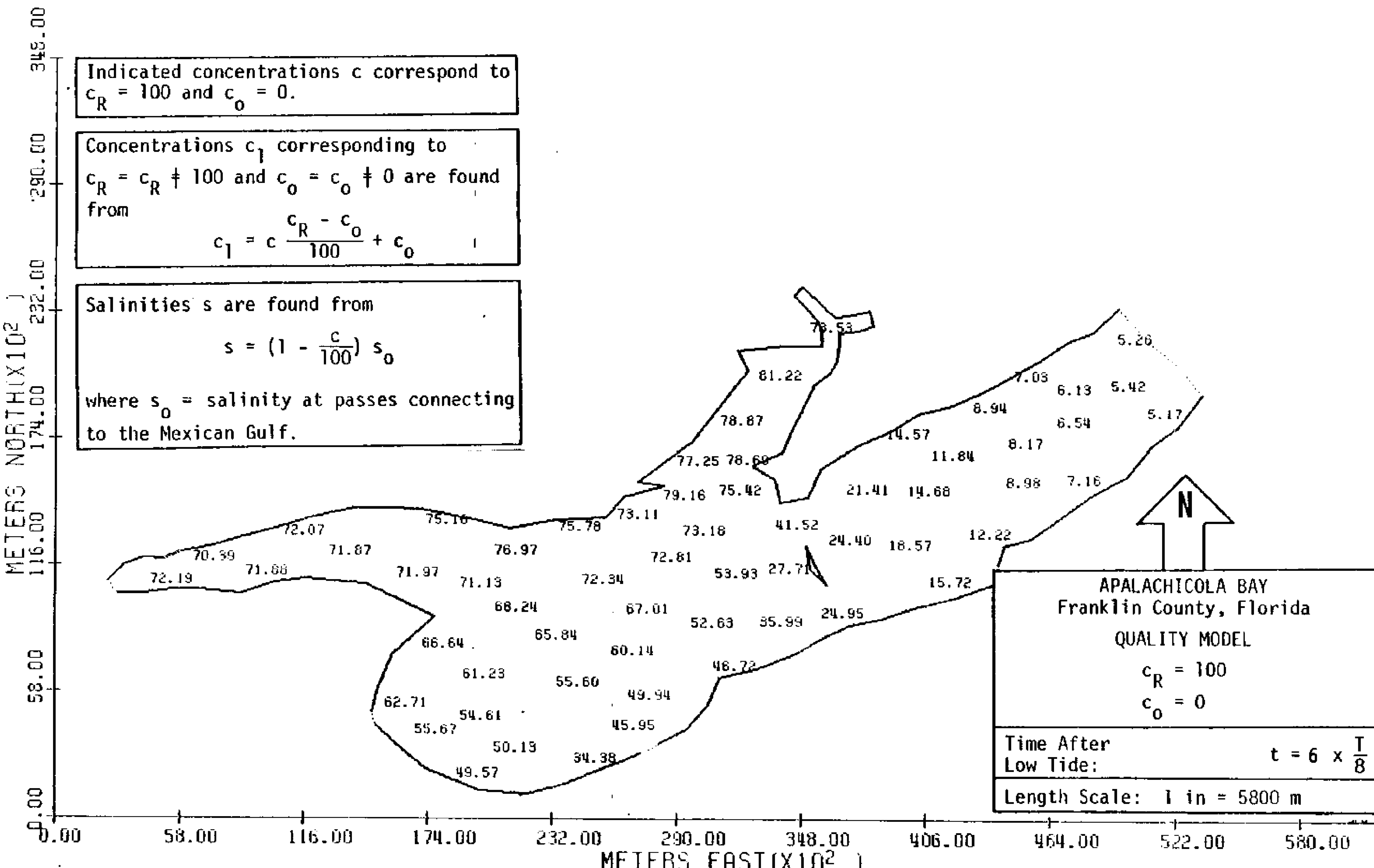


Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide: $t = 4 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00

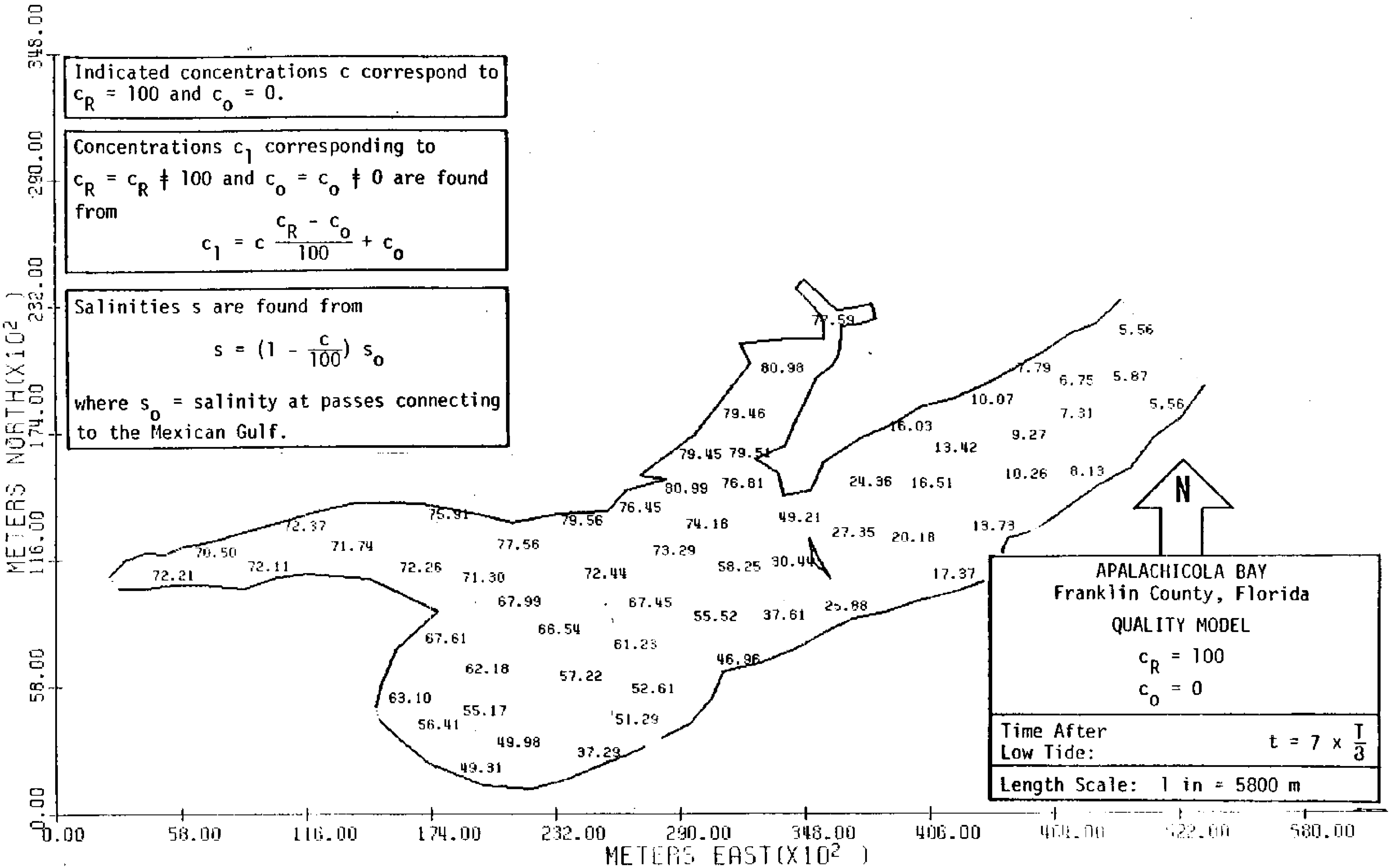
APR 14


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c\,\frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100})\,s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
N
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 5 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00

APR 15


Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c\,\frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = \left(1 - \frac{c}{100}\right) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide: $t = 6 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
72.19
70.39
71.68
72.07
71.87
71.97
75.16
71.13
76.97
68.24
66.64
65.84
61.23
62.71
54.61
55.67
50.13
49.57
75.78
72.34
55.60
34.38
73.11
67.01
60.14
49.94
45.95
79.16
77.25
75.42
73.18
72.61
52.63
78.68
78.87
81.22
78.53
53.93
46.72
41.52
27.71
35.99
24.40
24.95
21.41
18.57
14.68
14.57
11.84
15.72
12.22
8.98
8.94
8.17
7.16
7.03
6.54
6.13
5.42
5.26
5.17

APR 16

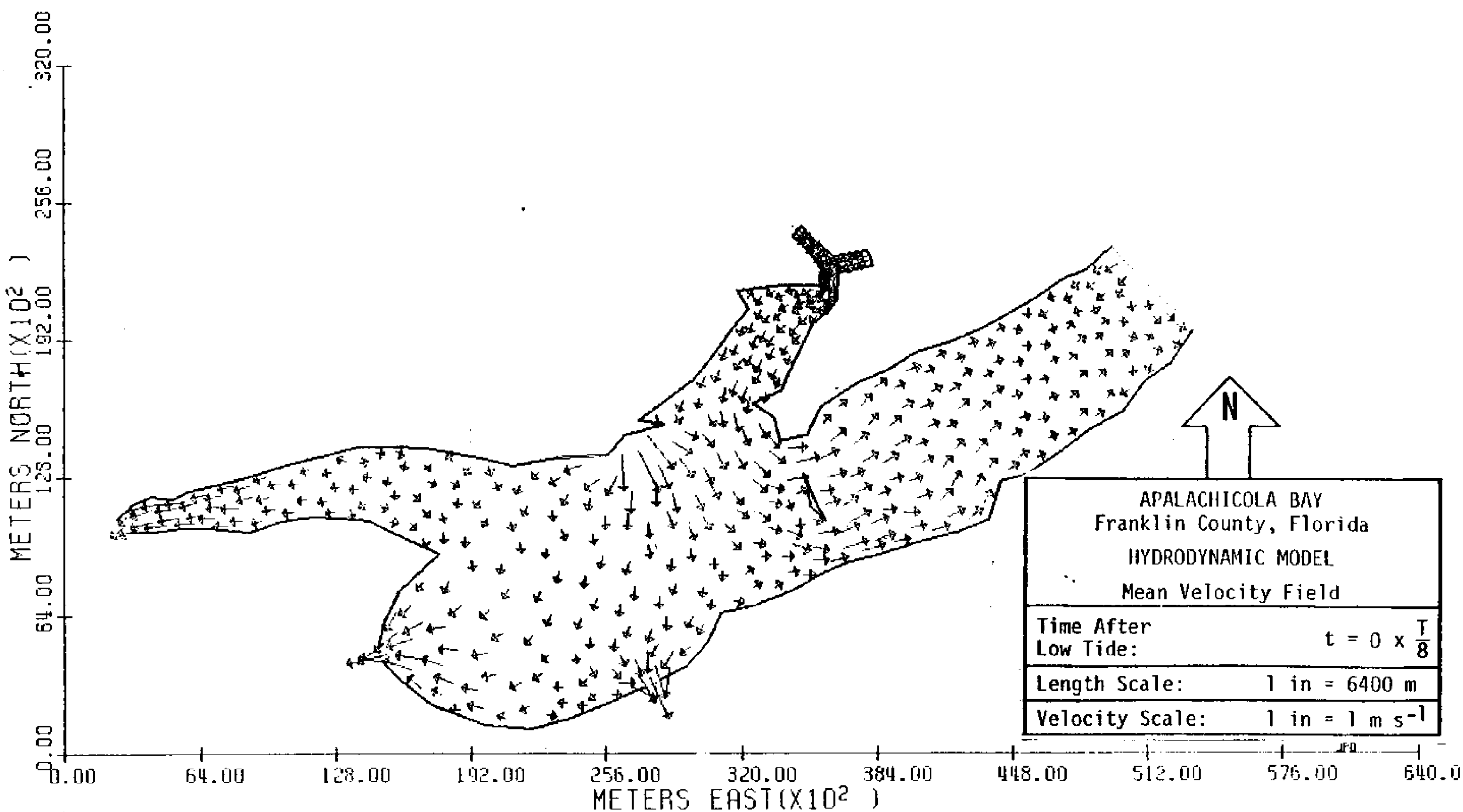


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c\,\frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = \left(1 - \frac{c}{100}\right) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
N
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide: $t = 7 \times \frac{T}{3}$
Length Scale: 1 in = 5800 m
METERS NORTH(X10^2)
METERS EAST(X10^2)

APR 17

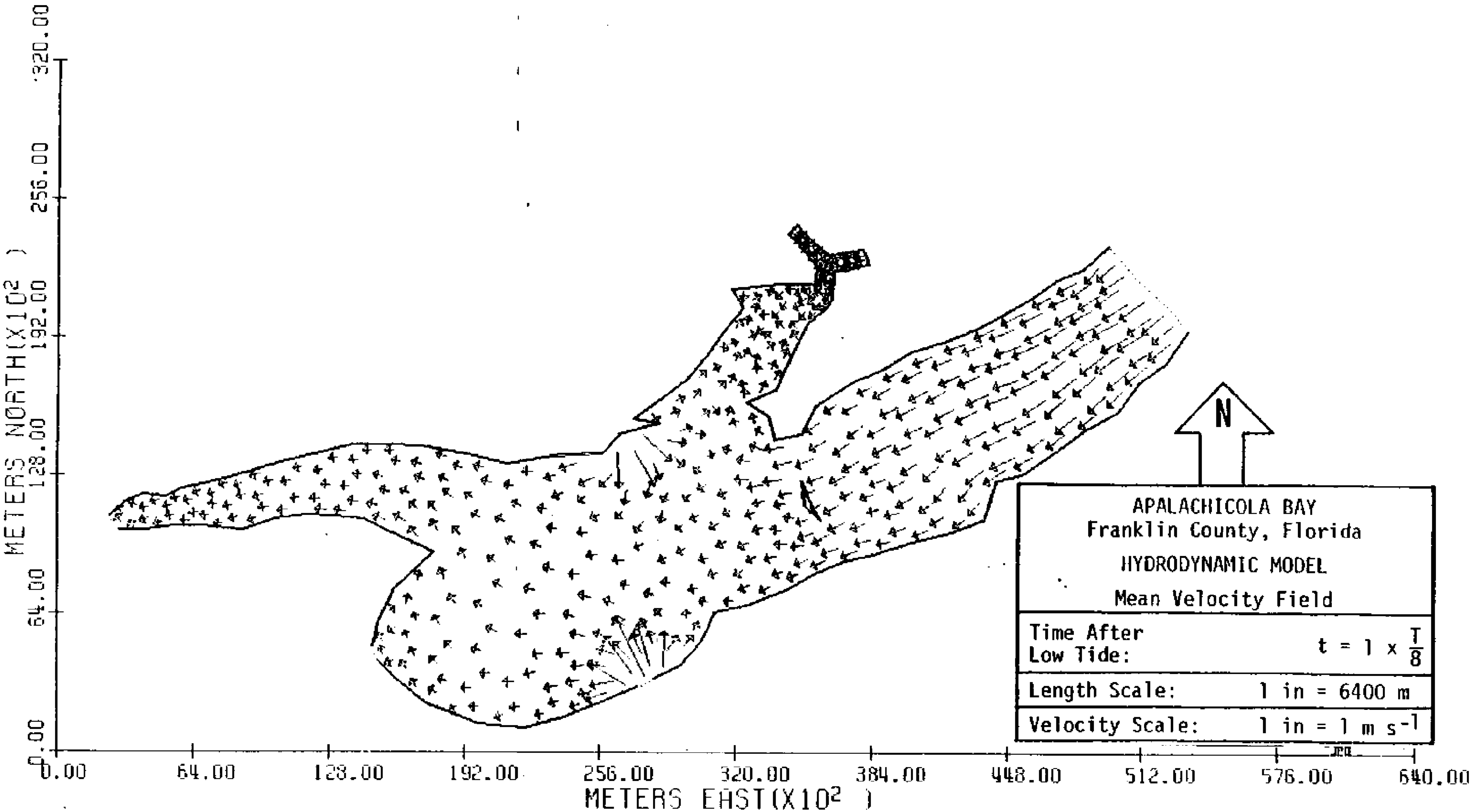
MAY

MAY 1 through MAY 8:	Vertically averaged velocities v_m given at time increments equal to one eighth of the tidal period beginning at low tide.
MAY 9:	Net values of vertically averaged velocities. Time averaged over one tidal cycle.
MAY 10 through MAY 17:	Vertically averaged pollutant concentration corresponding to river concentration c_R = 100 and concentration c_o = 0 at all inlets to bay. Concentrations given at time increments equal to one eighth of the tidal period beginning at low tide.



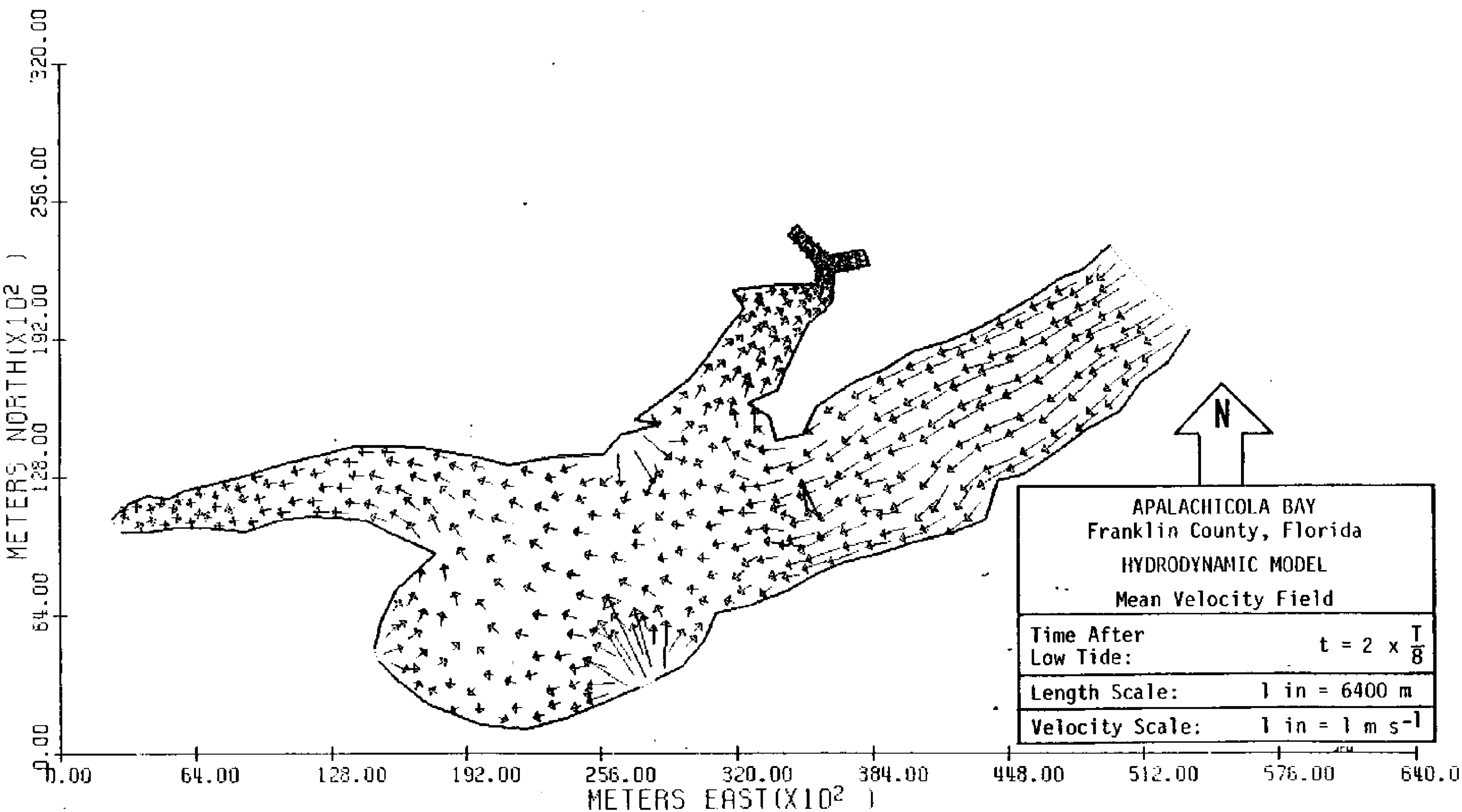
APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide:
t = 0 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

MAY 1



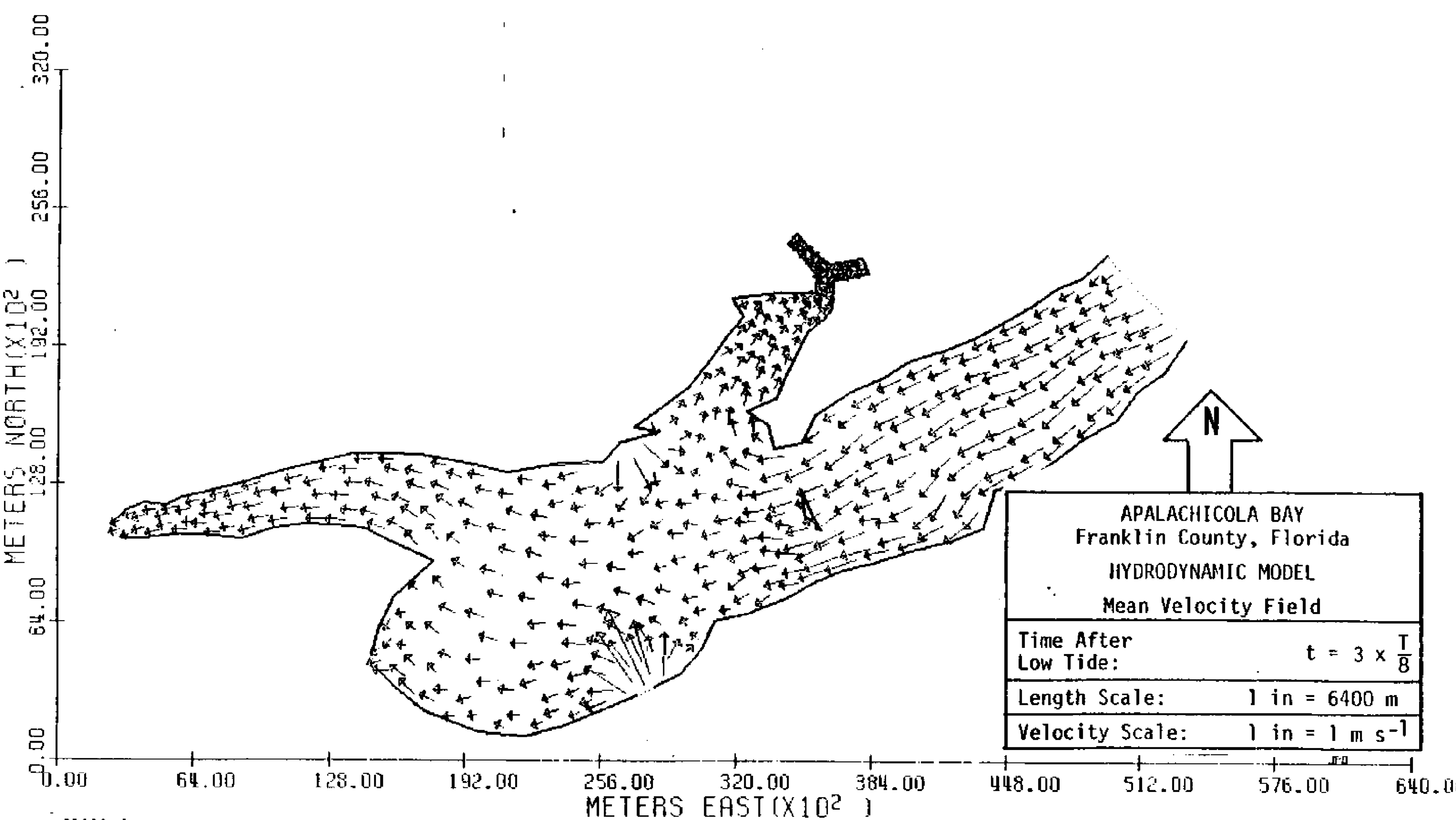
APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 1 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

MAY 2



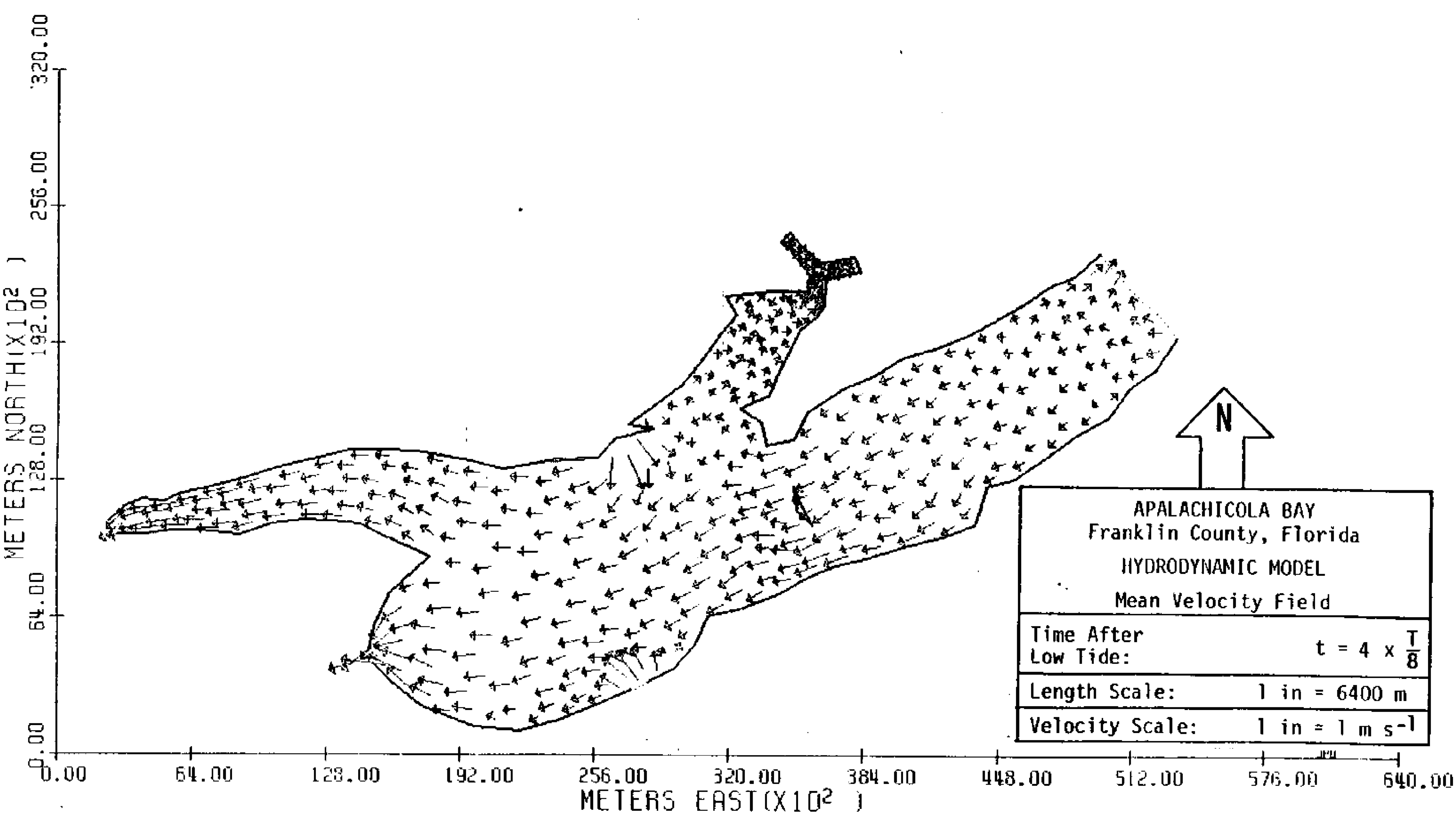
APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide:
$t = 2 \times \frac{T}{8}$
Length Scale:
1 in = 6400 m
Velocity Scale:
1 in = 1 m s^{-1}
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

MAY 3

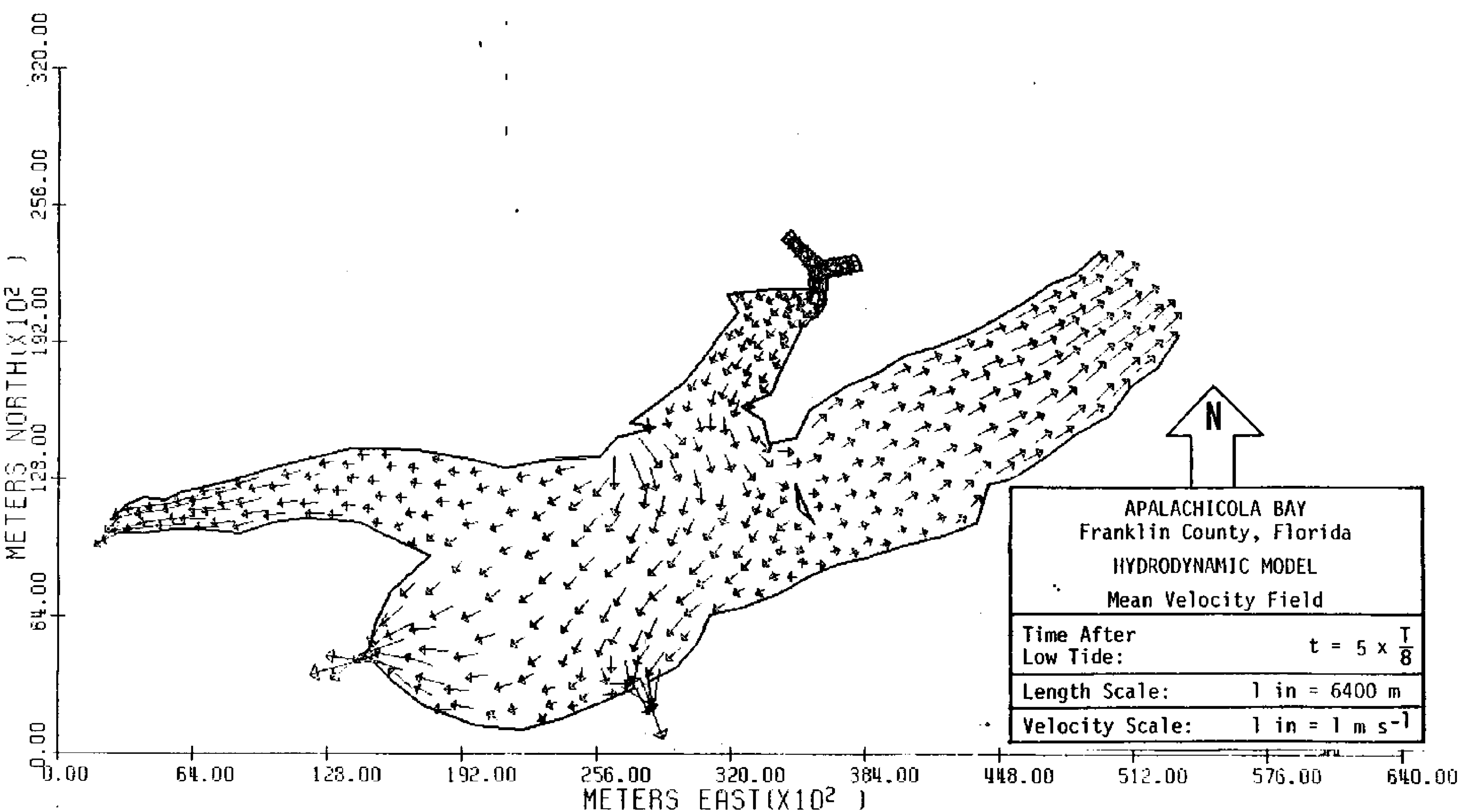


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 3 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

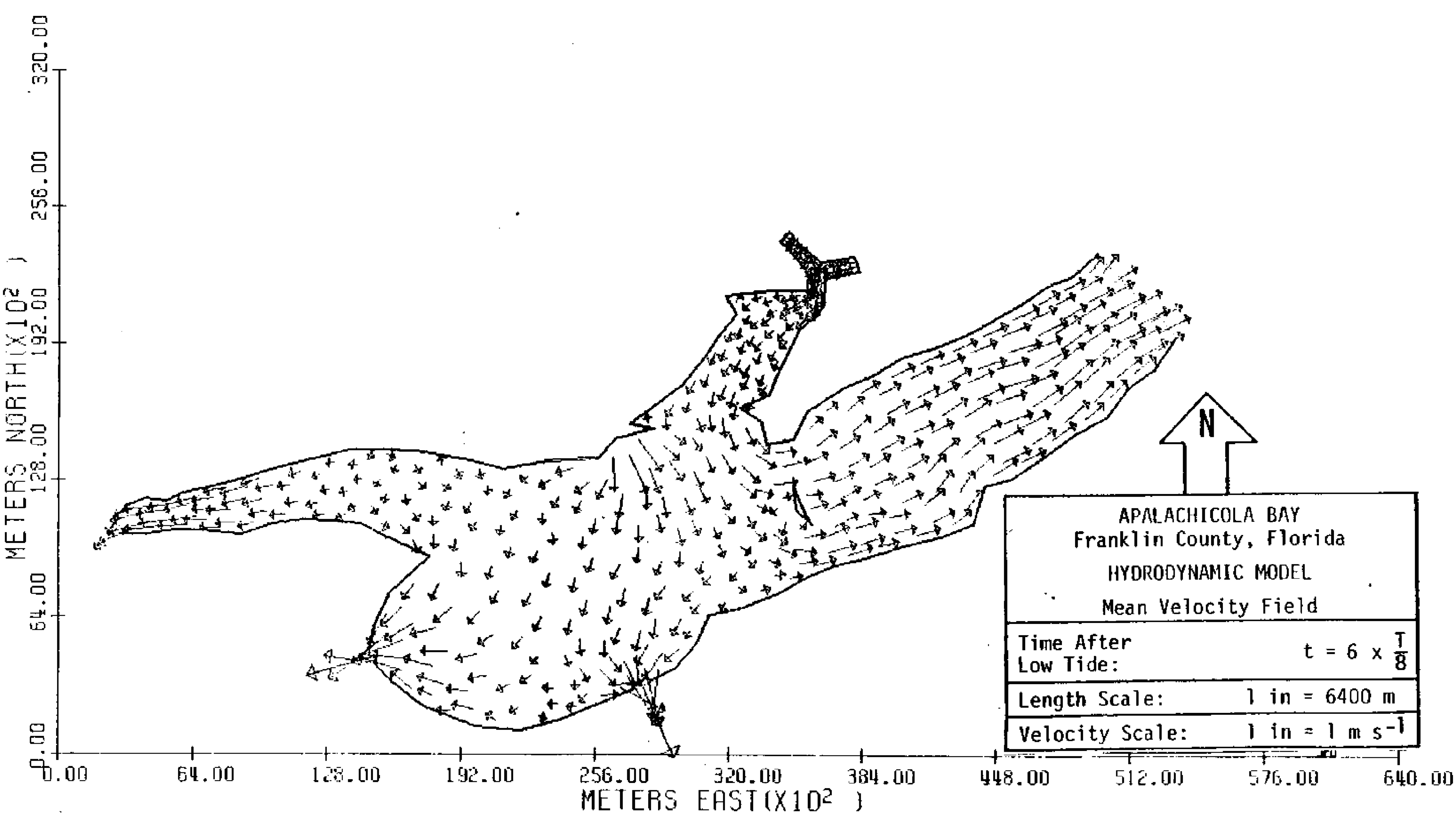
MAY 4


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 4 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

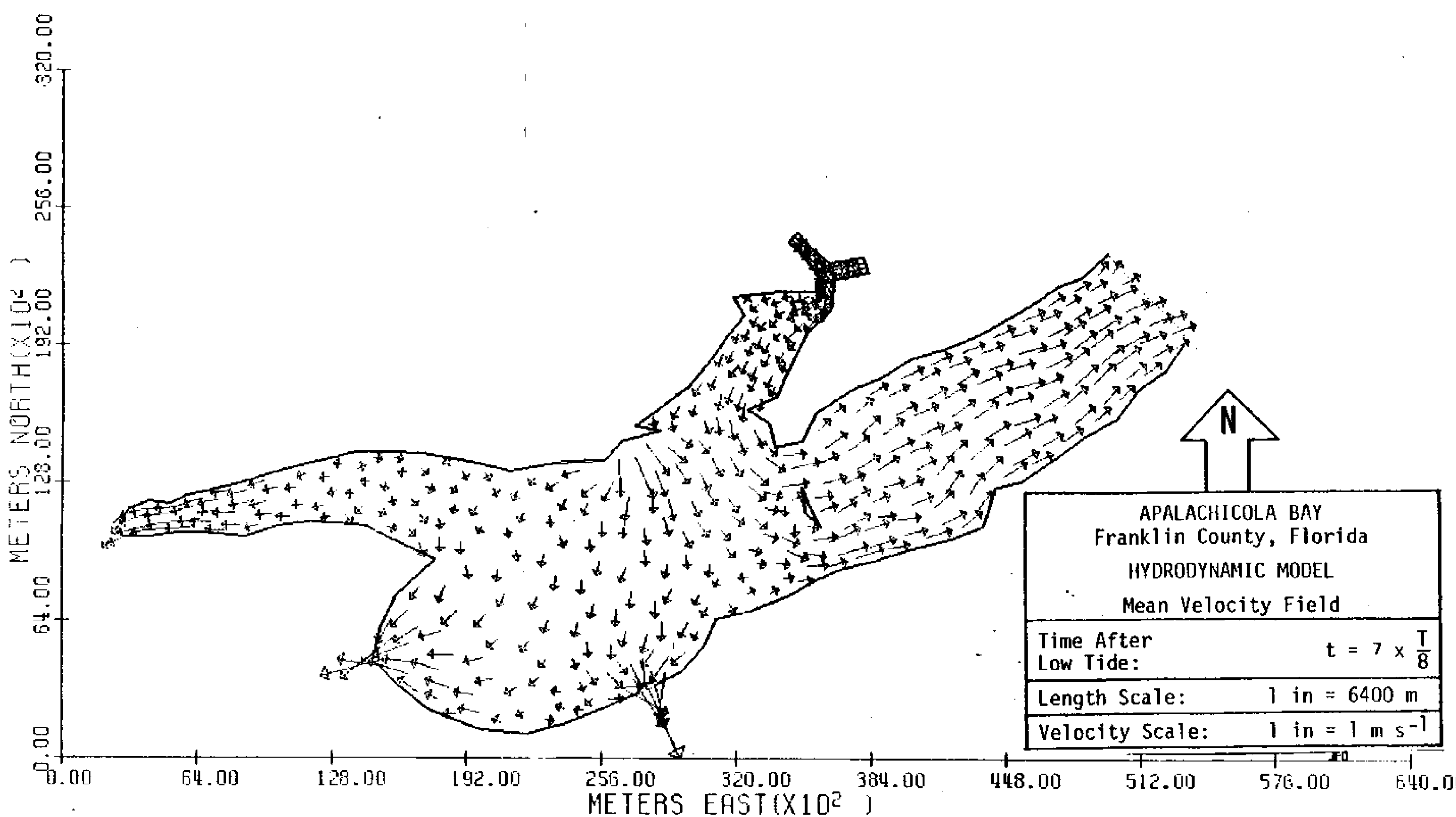
MAY 5


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 5 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH (X10²)
METERS EAST (X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

MAY 6

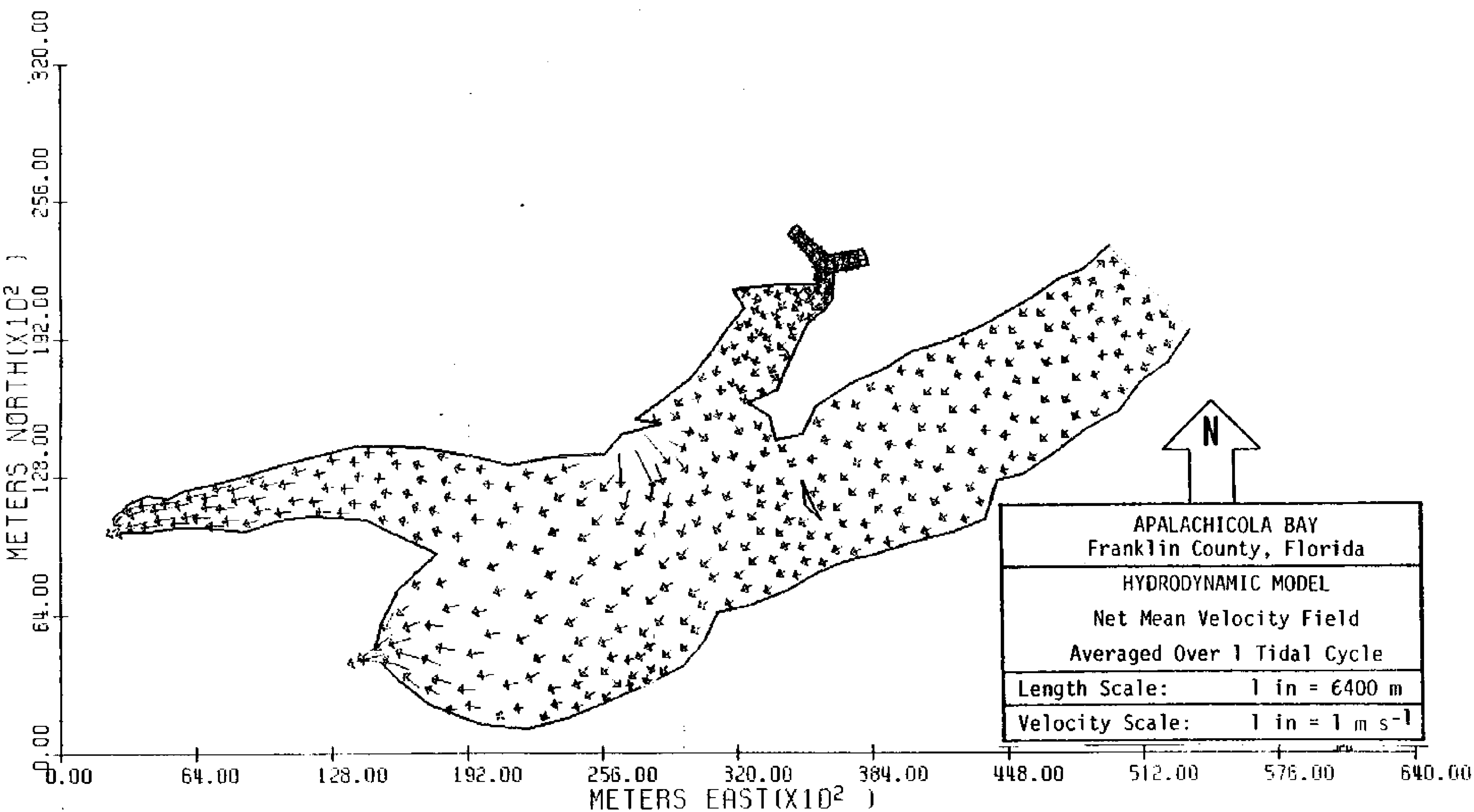

APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 6 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

MAY 7

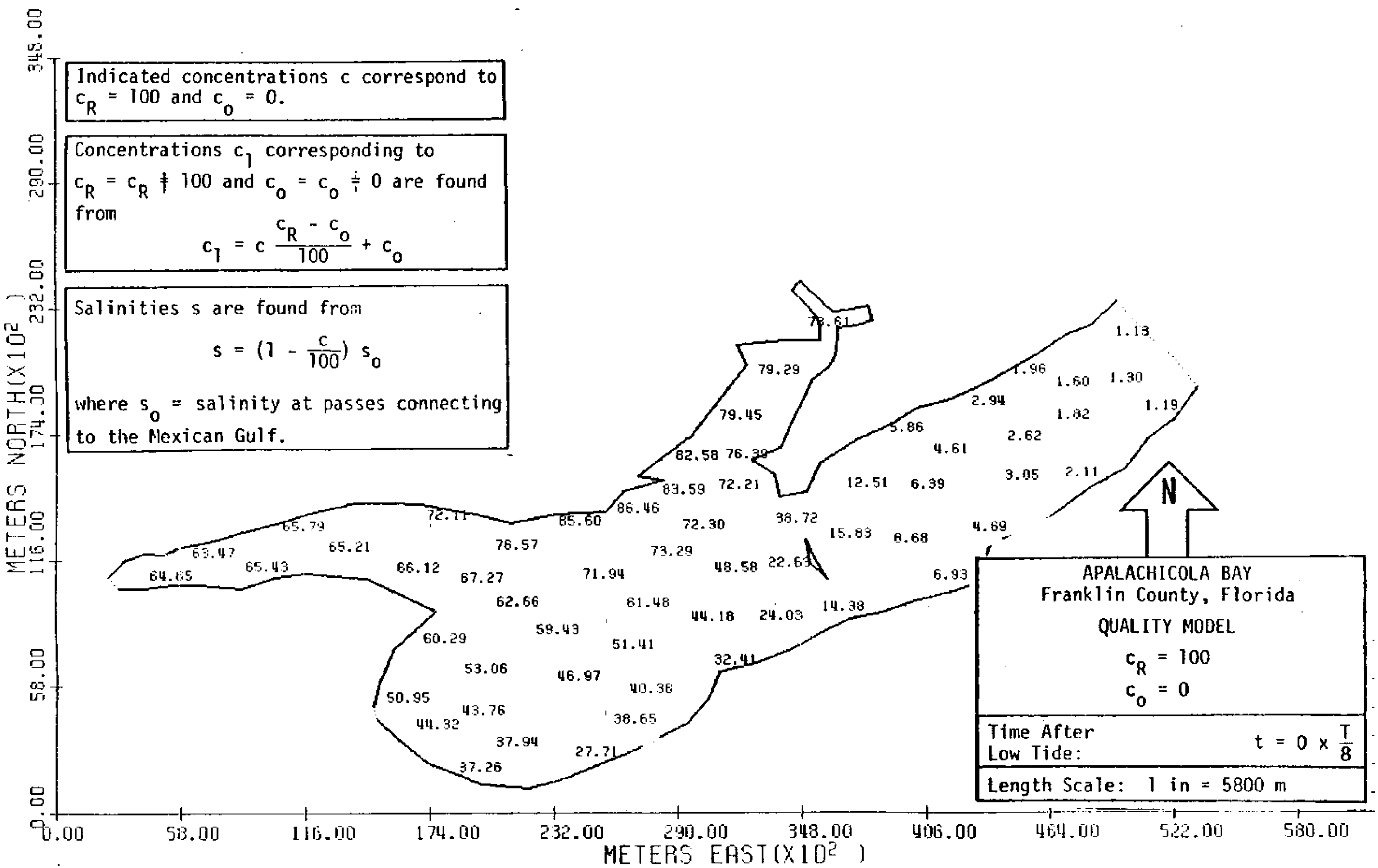


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 7 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

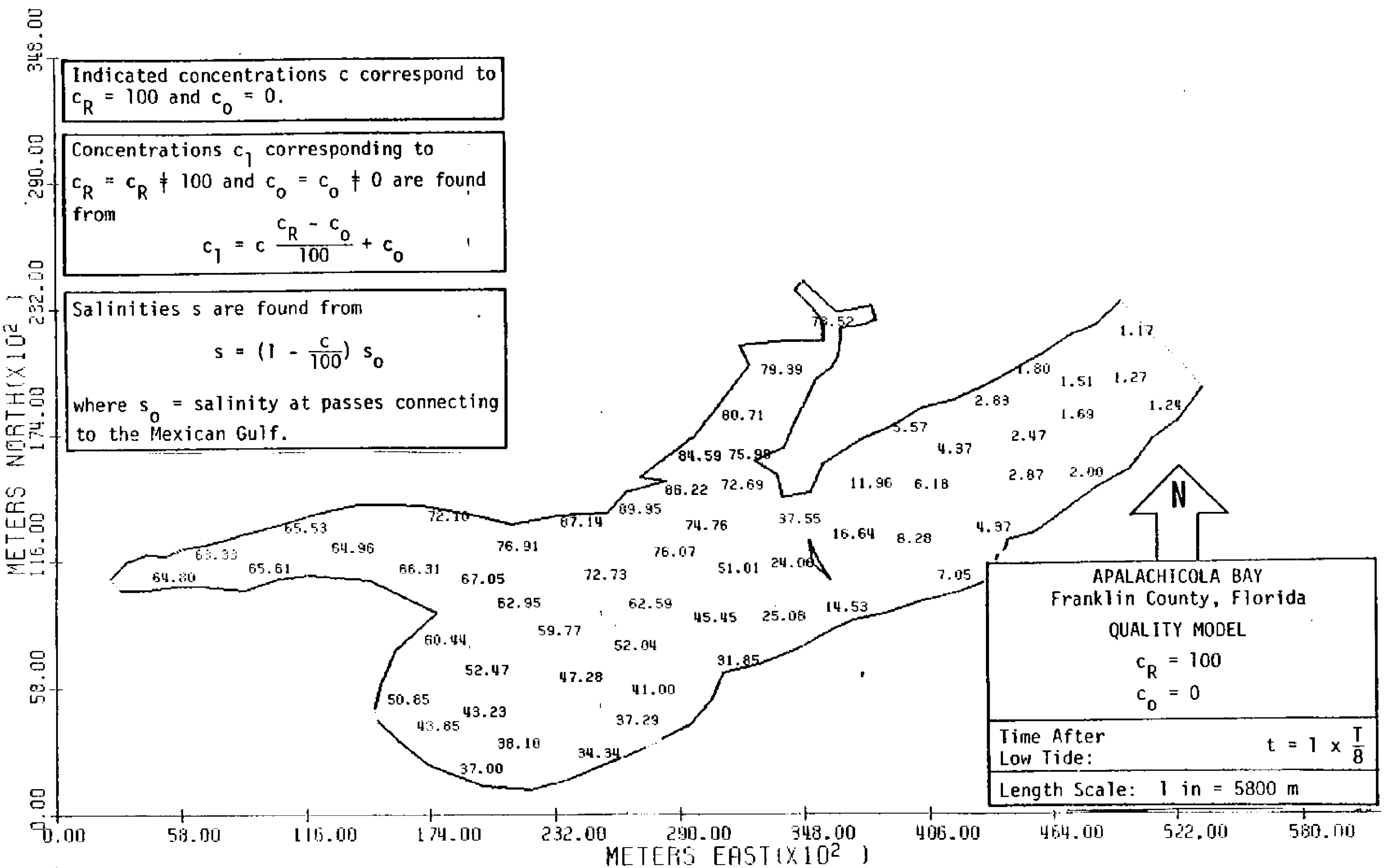
MAY 8


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Net Mean Velocity Field
Averaged Over 1 Tidal Cycle
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

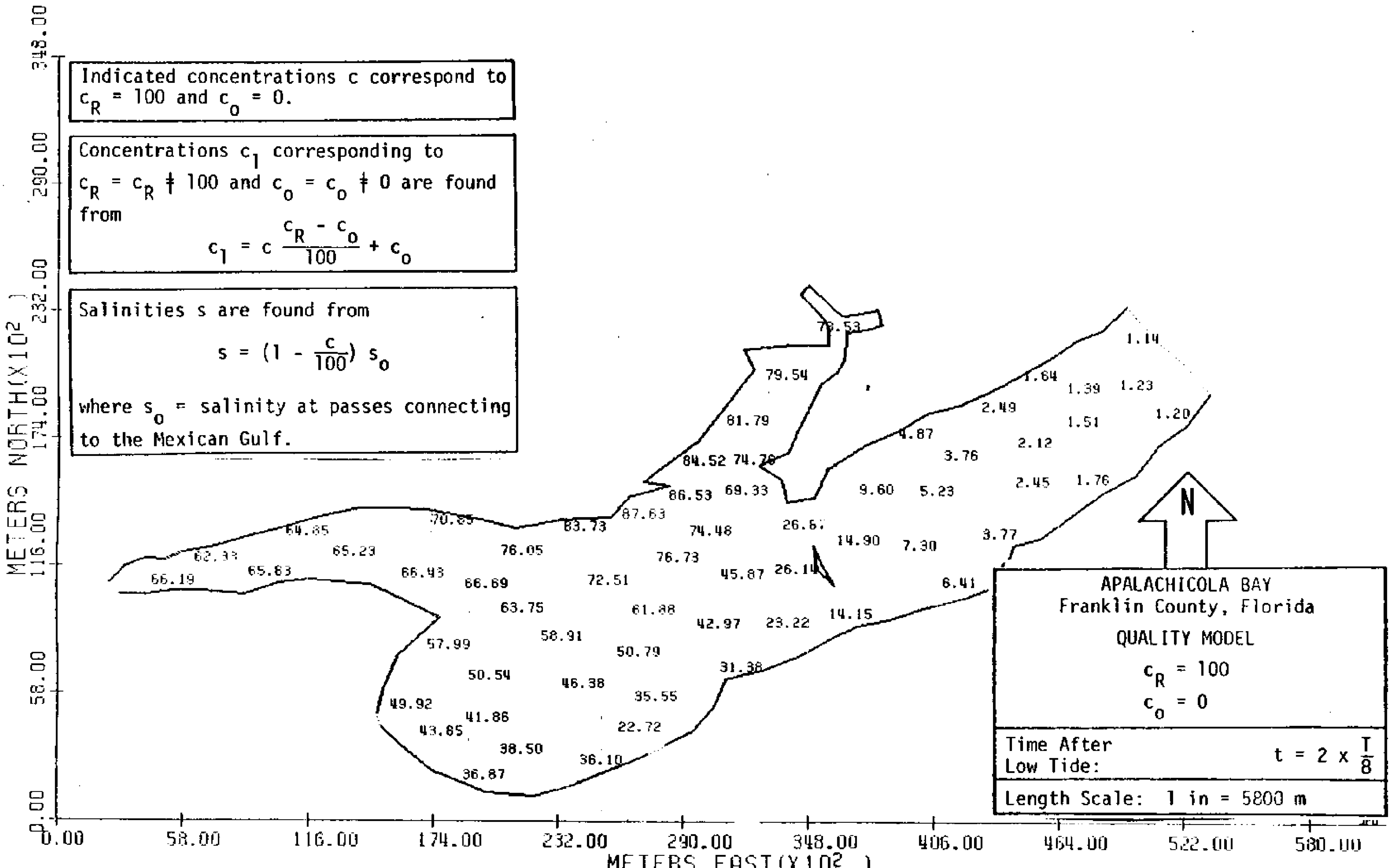
MAY 9


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 0 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)

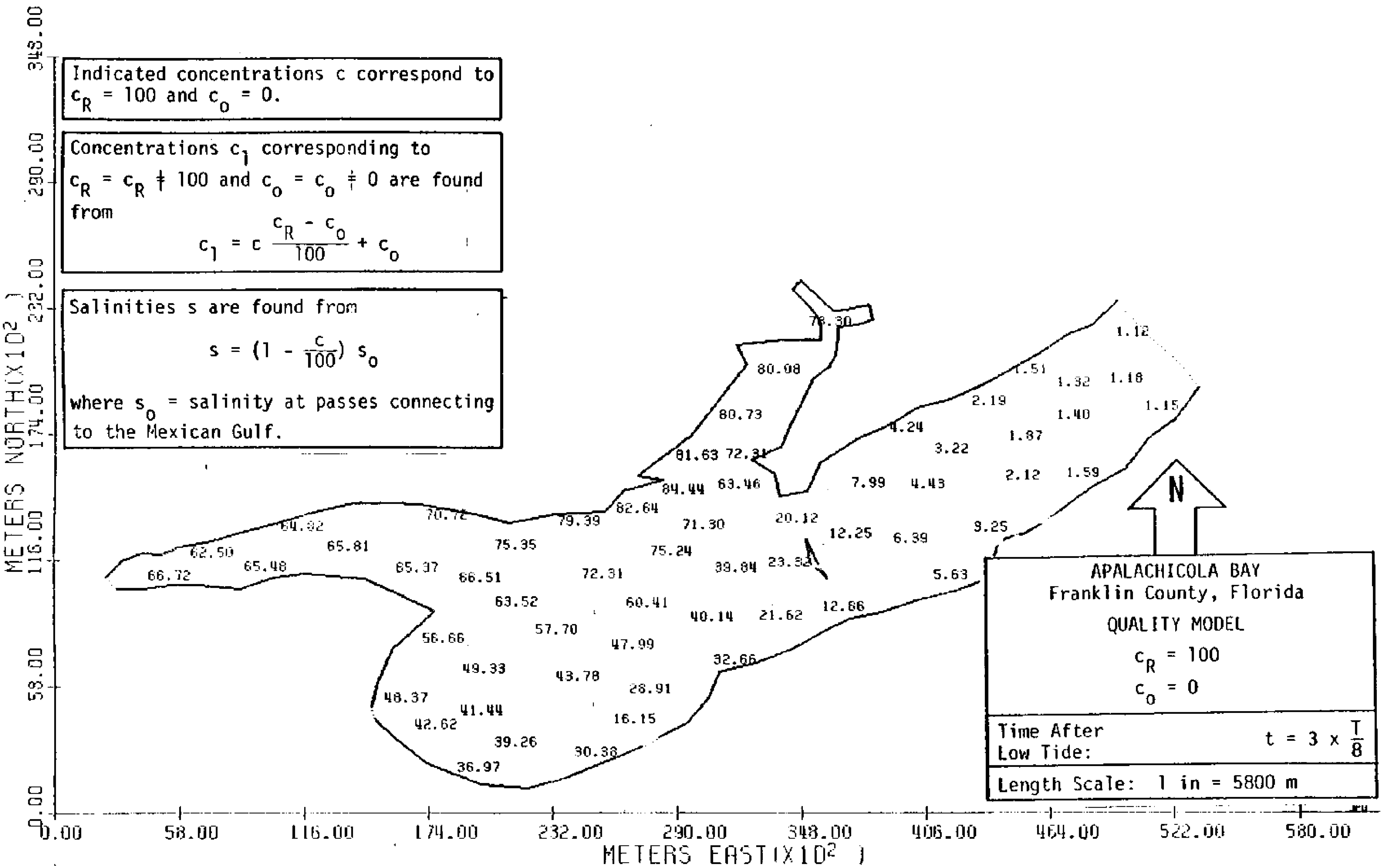
MAY 10


Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c\,\frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = (1 - \frac{c}{100})\, s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide: $t = 1 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
78.52
79.39
80.71
84.59
75.98
86.22
72.69
89.95
87.14
72.10
65.53
63.33
64.80
65.61
64.96
66.31
67.05
76.91
72.73
76.07
74.76
37.55
24.08
51.01
62.95
62.59
45.45
25.08
14.53
16.64
8.28
11.96
6.18
5.57
4.37
2.83
1.80
1.51
1.17
1.27
1.24
1.69
2.47
2.87
2.00
4.97
7.05
60.44
59.77
52.04
31.85
52.47
47.28
41.00
50.85
43.23
43.85
37.29
38.10
34.34
37.00

MAY 11

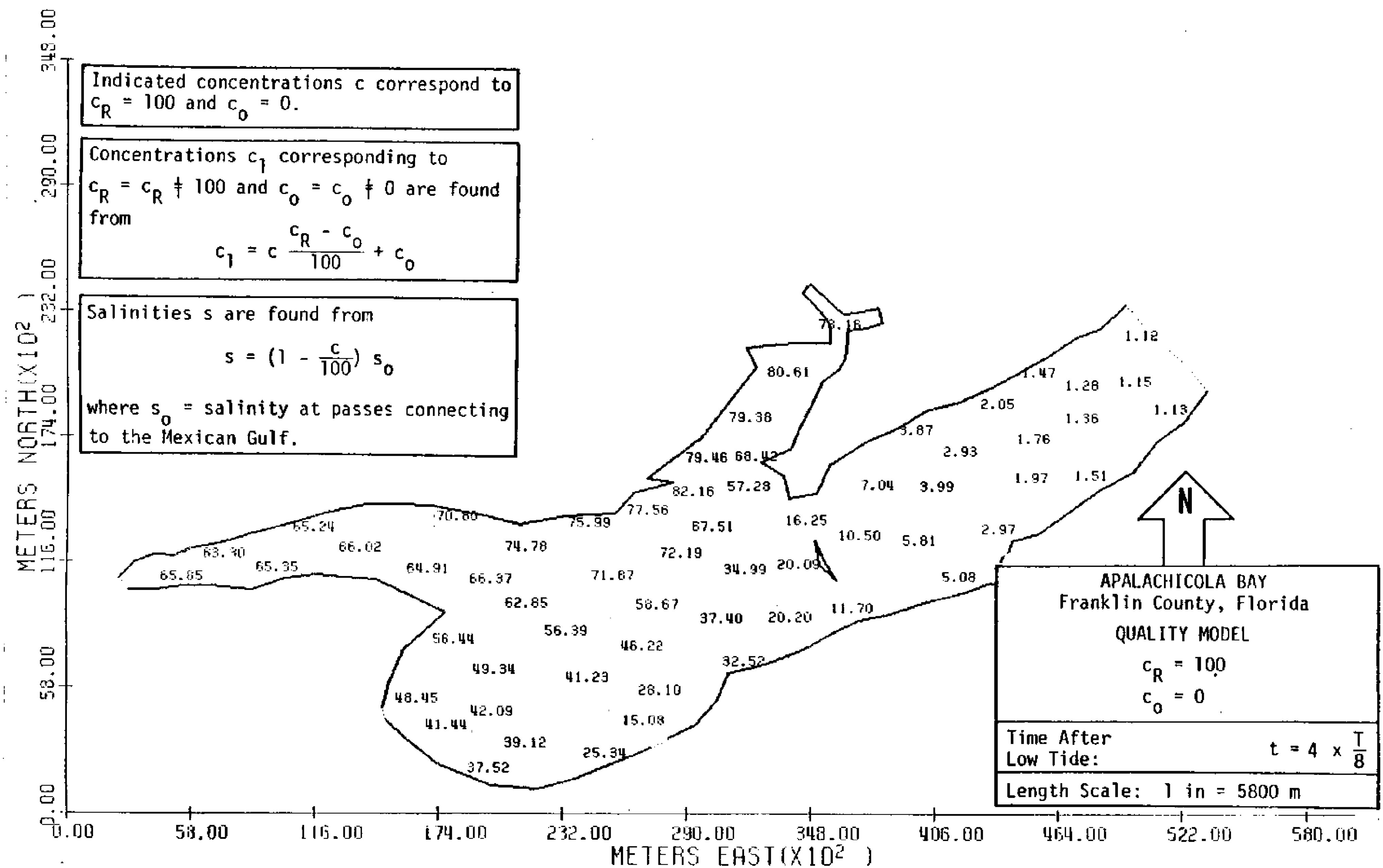

Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 2 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
79.54
81.79
84.52
74.78
86.53
69.33
87.63
74.48
76.73
45.87
26.14
26.67
14.90
7.30
9.60
5.23
4.87
3.76
2.49
2.12
1.64
1.39
1.51
1.23
1.14
1.20
2.45
1.76
3.77
6.41
14.15
23.22
42.97
61.88
72.51
83.73
76.05
70.85
66.93
66.69
63.75
58.91
50.79
31.38
57.99
50.54
46.38
35.55
49.92
41.86
43.85
22.72
38.50
36.10
36.87
64.85
65.23
62.33
65.83
66.19

MAY 12

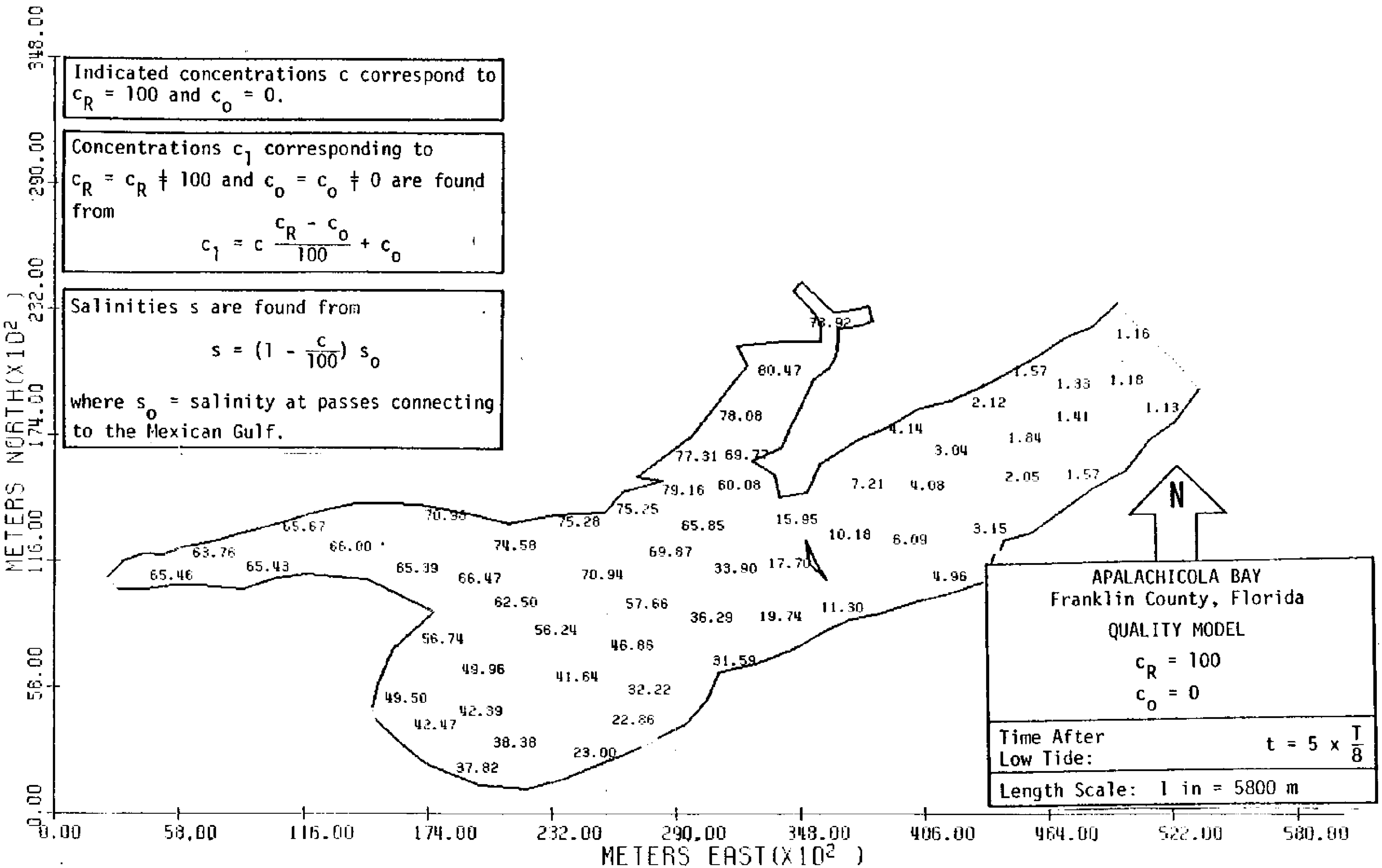


Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c \frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = (1 - \frac{c}{100}) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide: $t = 3 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
66.72
62.50
65.48
64.92
65.81
65.37
70.72
66.51
75.35
63.52
56.66
49.33
48.37
42.62
41.44
36.97
39.26
57.70
43.78
79.39
72.31
30.38
16.15
28.91
47.99
60.41
75.24
71.30
82.64
84.44
81.63
72.31
63.46
80.73
80.08
78.30
40.14
39.84
21.62
32.66
12.86
23.32
20.12
12.25
7.99
6.39
4.43
4.24
3.22
5.63
9.25
2.12
1.87
2.19
1.51
1.32
1.40
1.59
1.18
1.12
1.15

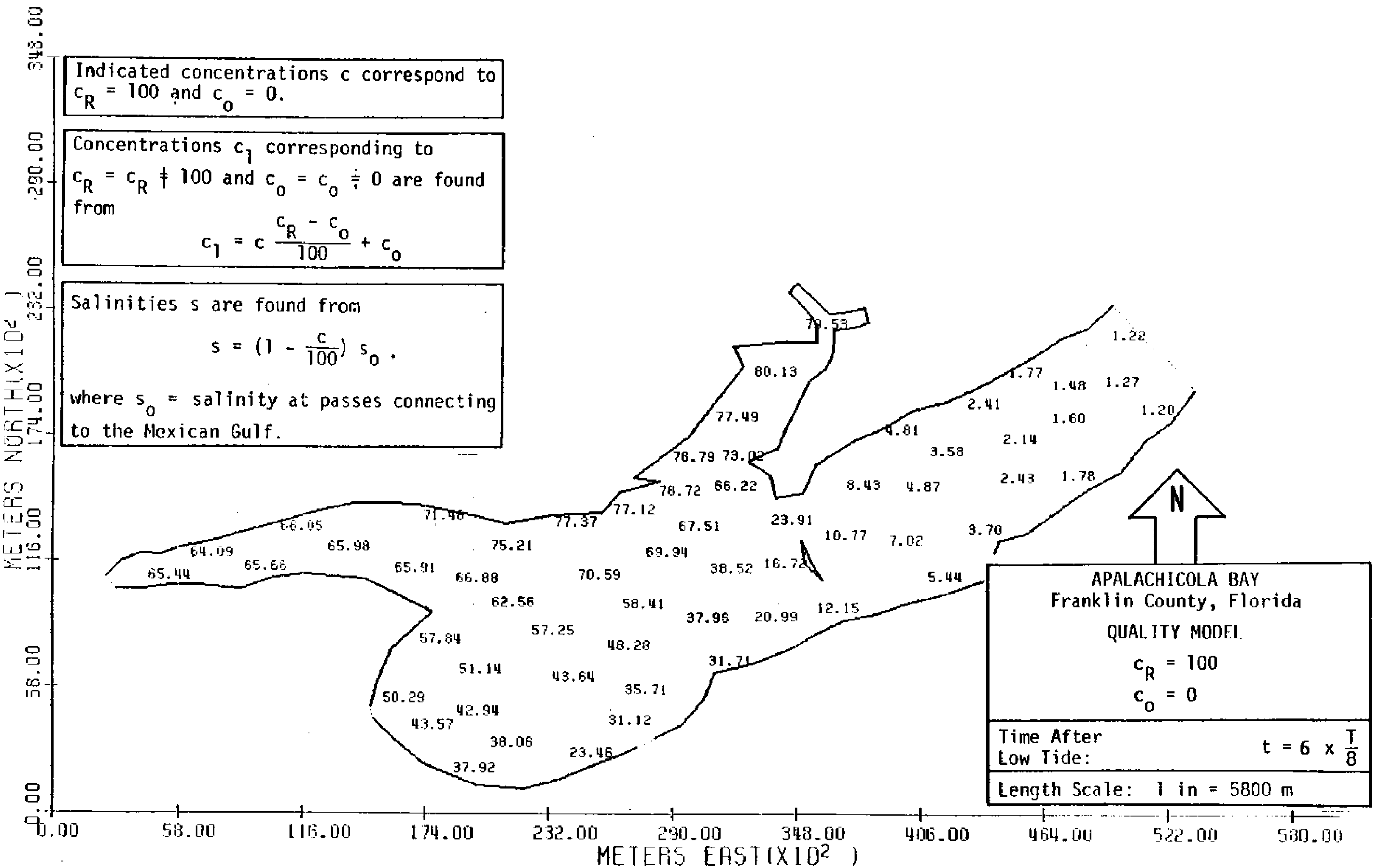
MAY 13


Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c \frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = (1 - \frac{c}{100})\, s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide: $t = 4 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
65.65
63.30
65.35
65.24
66.02
64.91
70.80
66.37
74.78
62.85
56.44
49.34
48.45
41.44
42.09
39.12
37.52
56.39
41.23
25.34
75.99
71.87
77.56
82.16
79.46
68.42
57.28
67.51
72.19
58.67
46.22
28.10
15.08
37.40
32.52
34.99
20.20
20.09
16.25
79.38
80.61
78.16
11.70
10.50
7.04
5.81
5.08
3.99
3.87
2.93
2.97
2.05
1.97
1.76
1.47
1.51
1.36
1.28
1.15
1.12
1.13

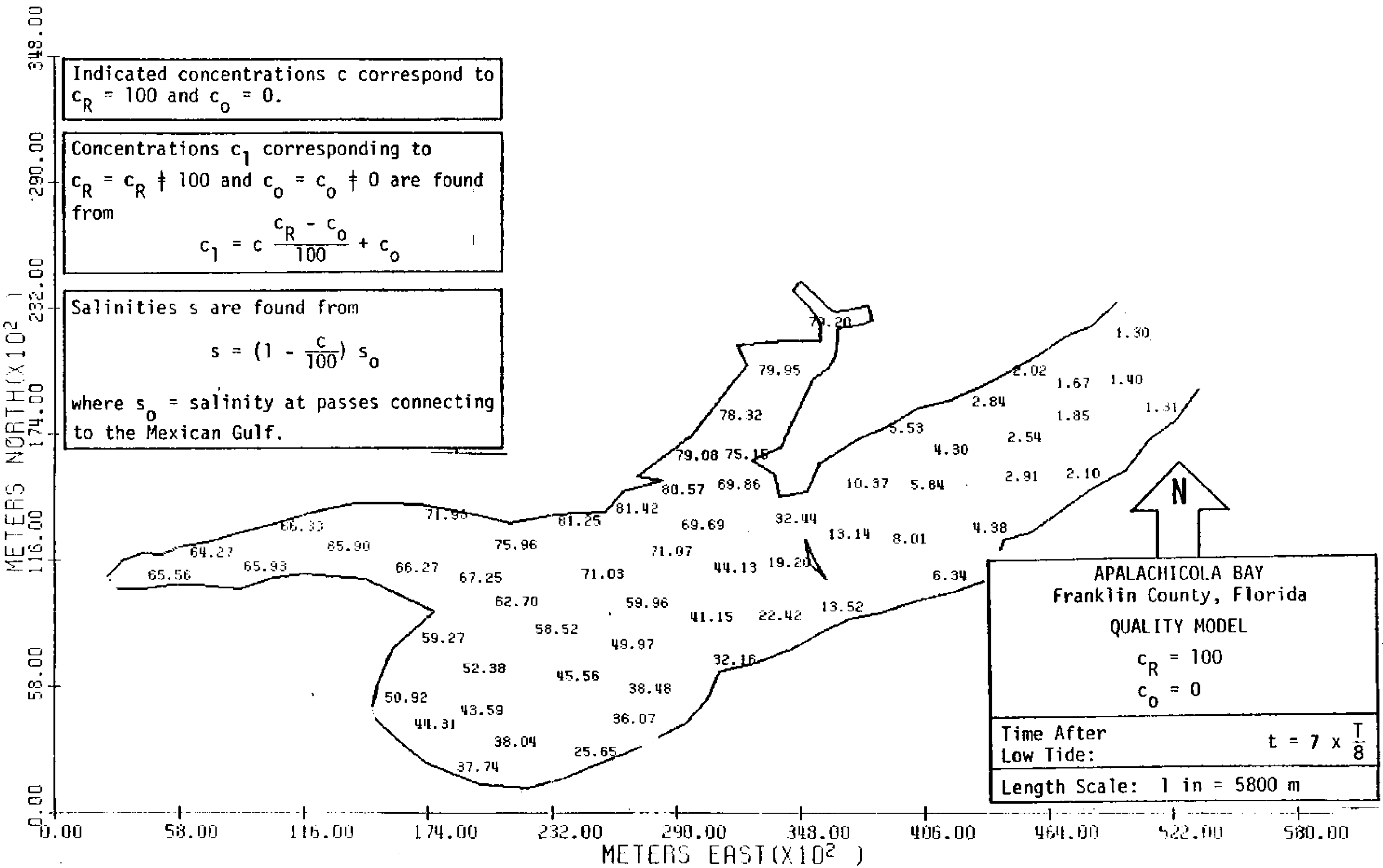
MAY 14


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c \frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = (1 - \frac{c}{100}) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 5 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
78.92
80.47
78.08
77.31
69.72
79.16
60.08
75.25
75.28
70.30
65.67
63.76
65.46
65.43
66.00
65.39
74.58
66.47
62.50
70.94
65.85
69.87
57.66
56.24
56.74
49.96
49.50
42.47
42.39
38.38
37.82
41.64
46.86
32.22
22.86
23.00
36.29
33.90
15.95
17.70
19.74
31.59
11.30
10.18
6.09
7.21
4.08
4.14
3.04
4.96
3.15
2.05
1.84
2.12
1.57
1.33
1.41
1.57
1.16
1.18
1.13

MAY 15


Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$.
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide:
$t = 6 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
65.44
64.09
65.66
66.05
65.98
71.46
65.91
66.88
75.21
77.37
77.12
78.72
76.79
73.02
77.49
80.13
66.22
67.51
69.94
70.59
62.56
57.84
57.25
58.41
48.28
51.14
43.64
50.29
42.94
43.57
38.06
37.92
23.46
31.12
35.71
31.71
37.96
20.99
38.52
16.72
23.91
10.77
12.15
8.43
7.02
4.87
5.44
3.70
3.58
4.81
2.41
2.43
2.14
1.78
1.77
1.48
1.60
1.27
1.22
1.20

MAY 16

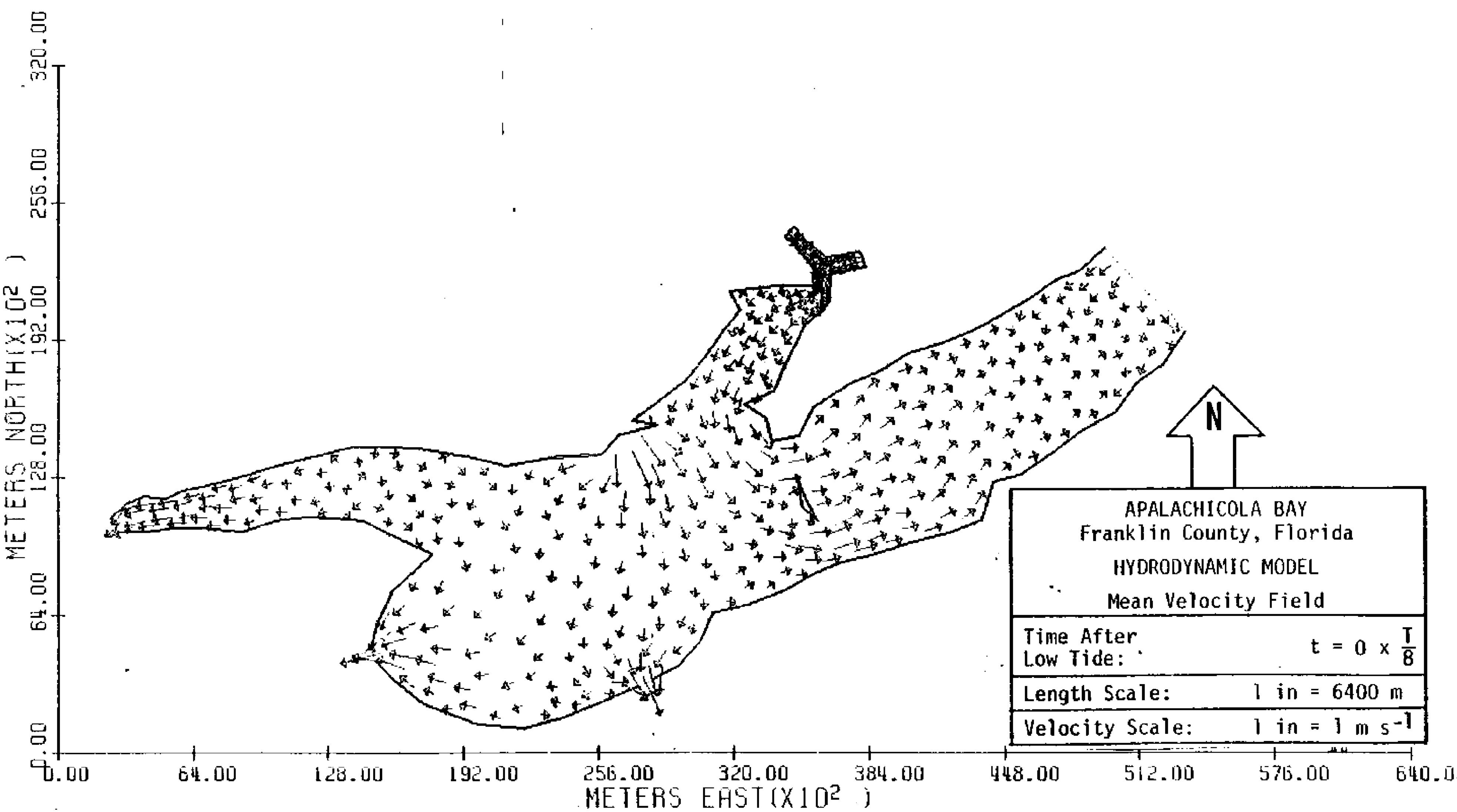


Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide:
$t = 7 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00

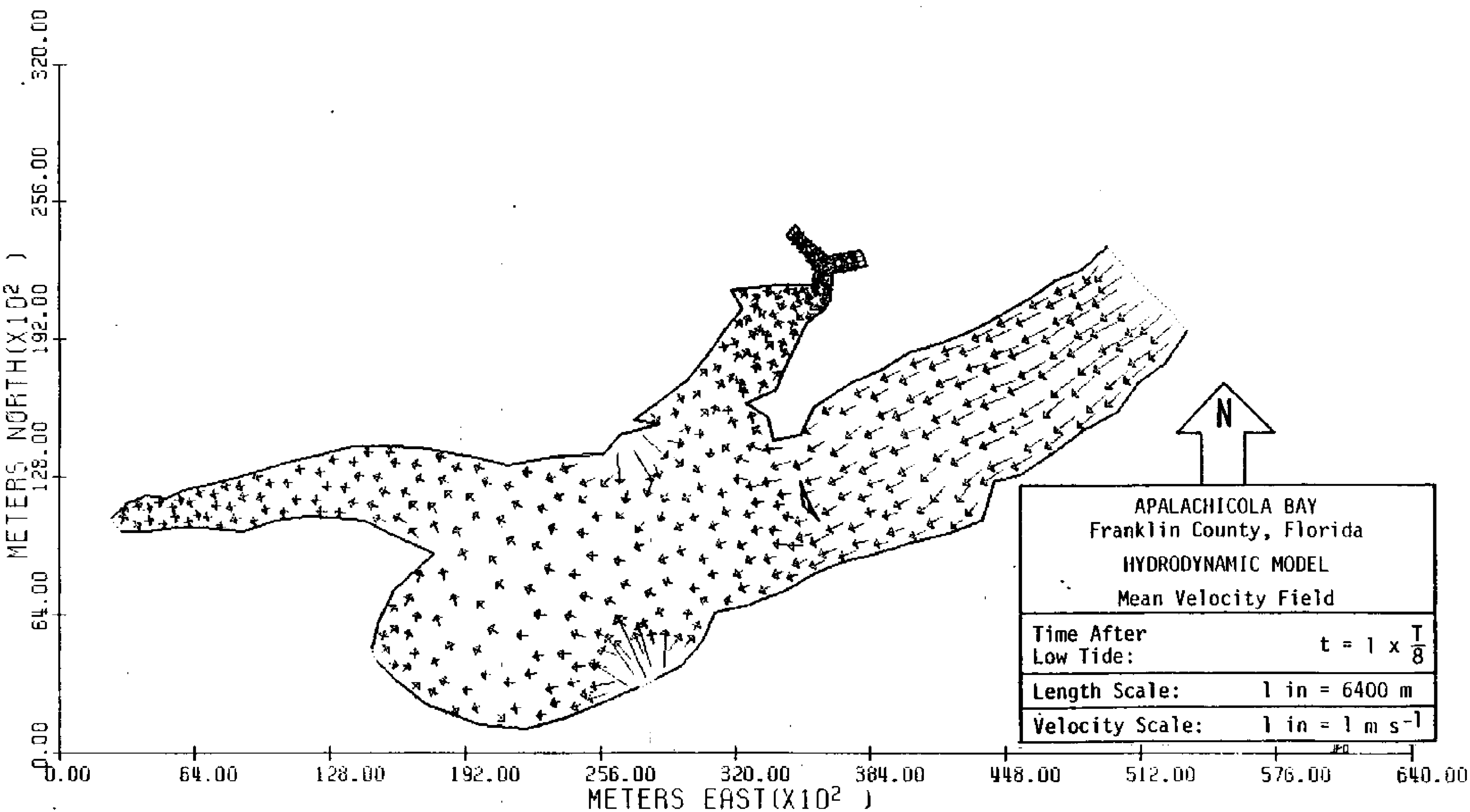
MAY 17

JUNE

JUN 1 through JUN 8:	Vertically averaged velocities v_m given at time increments equal to one eighth of the tidal period beginning at low tide.
JUN 9:	Net values of vertically averaged velocities. Time averaged over one tidal cycle.
JUN 10 through JUN 17:	Vertically averaged pollutant concentration corresponding to river concentration c_R = 100 and concentration c_o = 0 at all inlets to bay. Concentrations given at time increments equal to one eighth of the tidal period beginning at low tide.

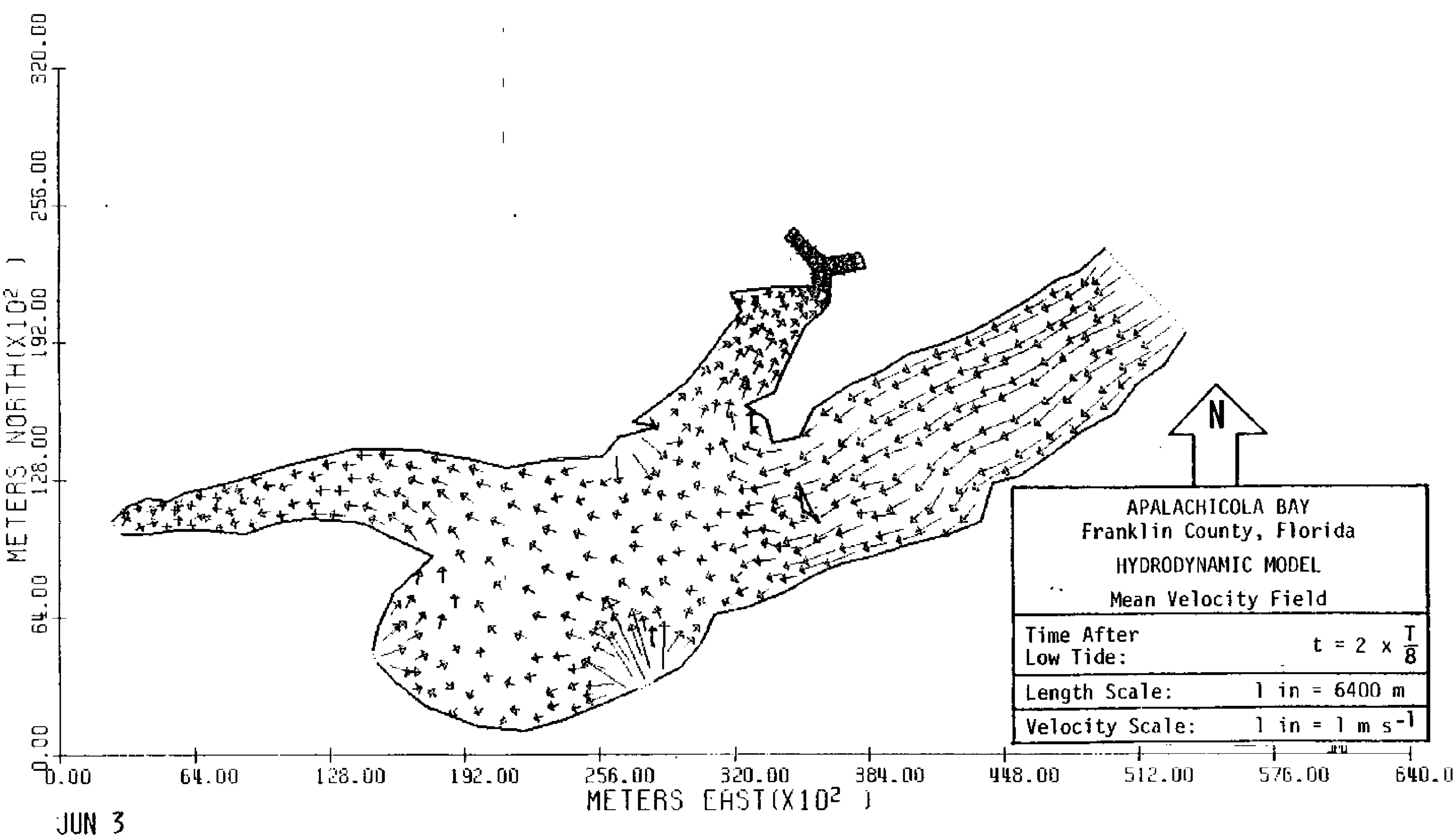

APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 0 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

JUN 1

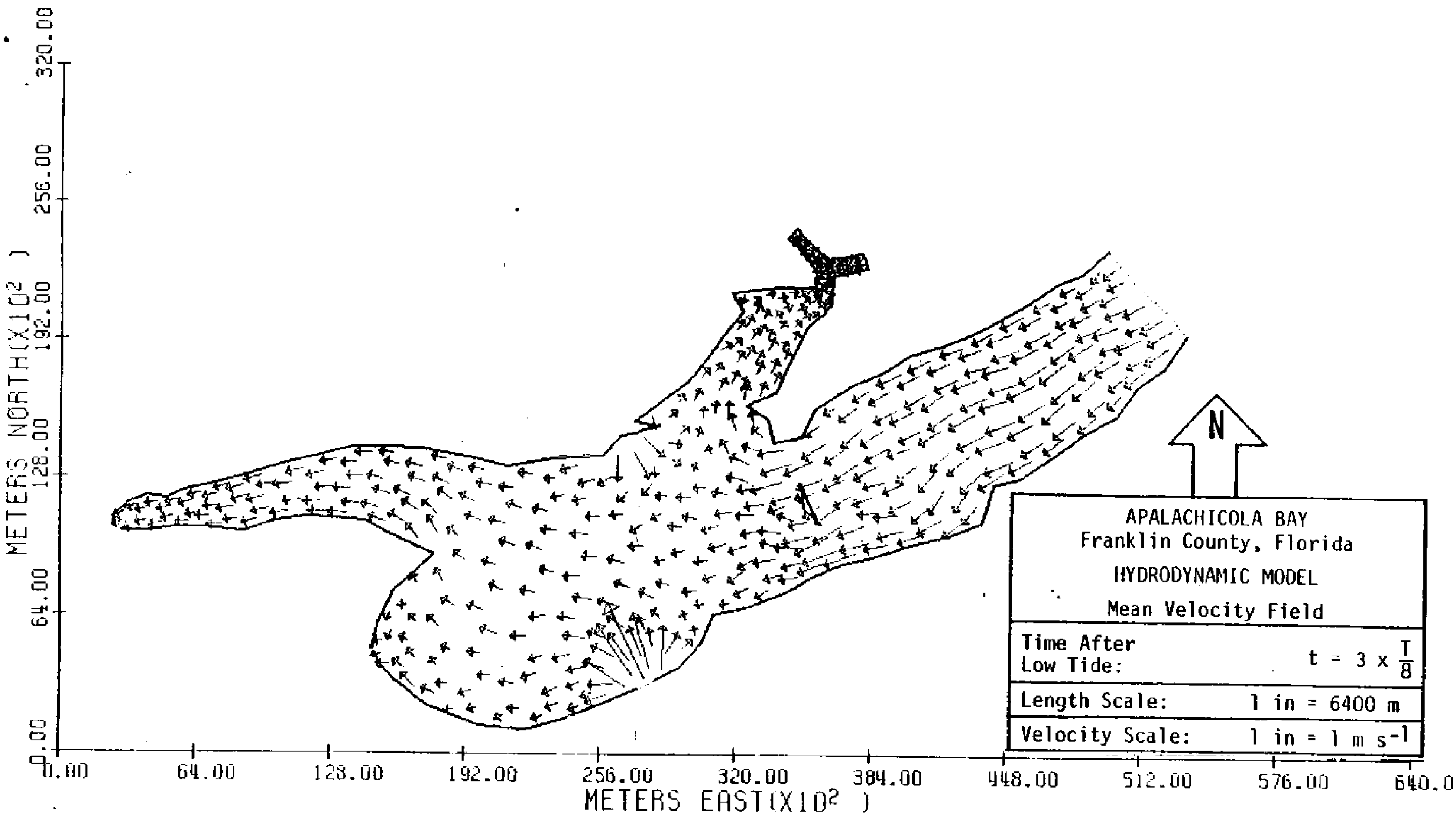


METERS NORTH(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00
N
APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 1 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s⁻¹

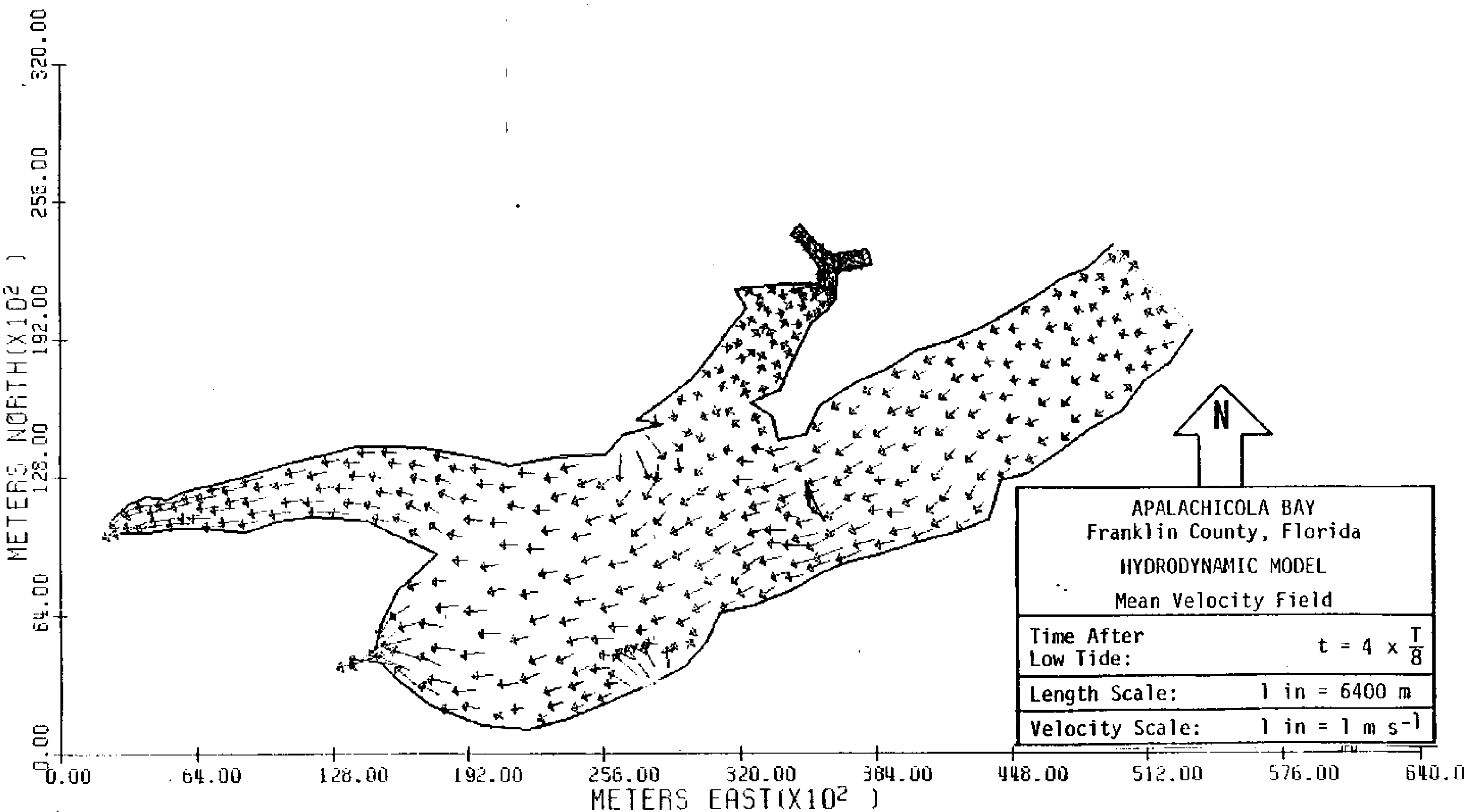
JUN 2



APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 2 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00
JUN 3

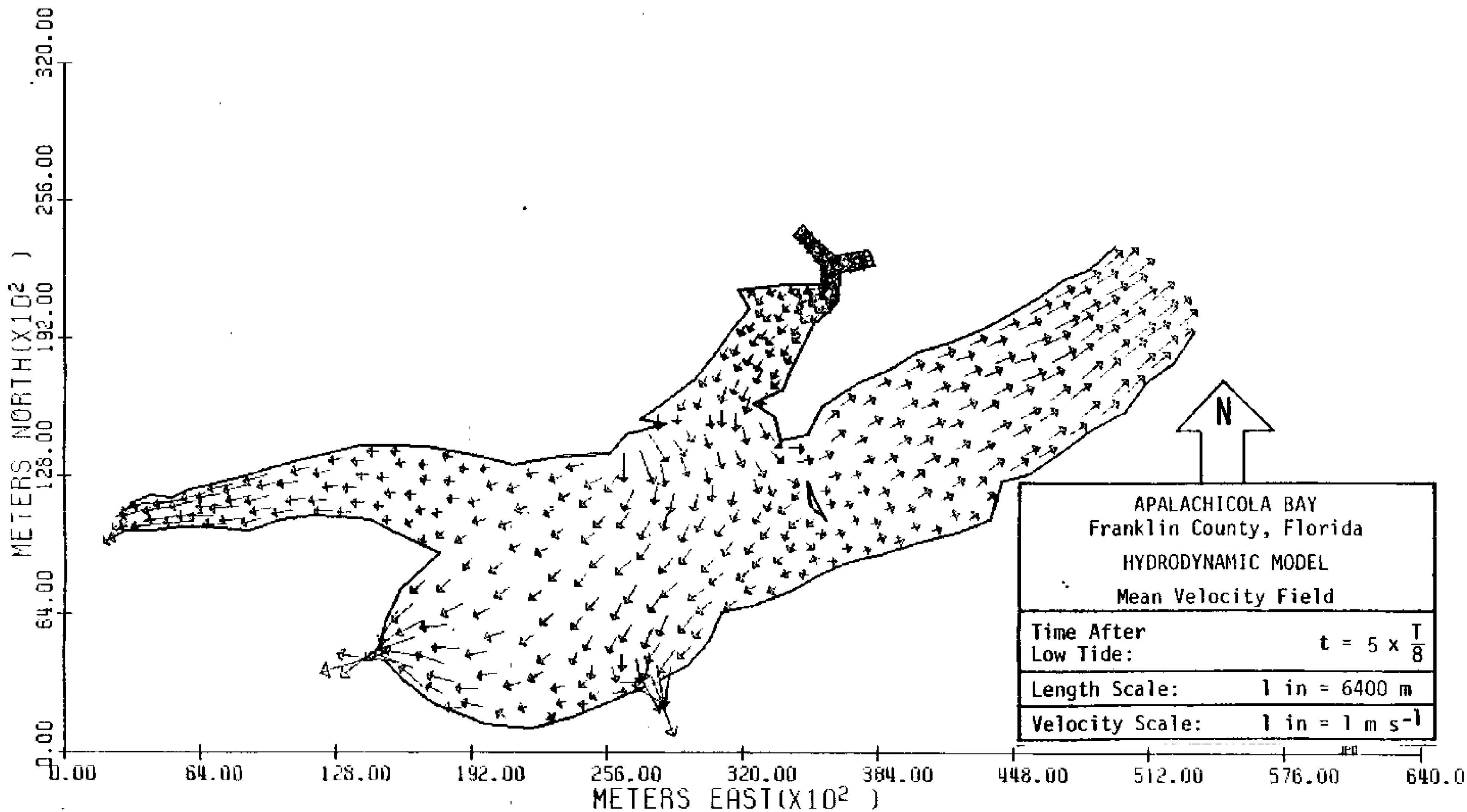

APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 3 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

JUN 4

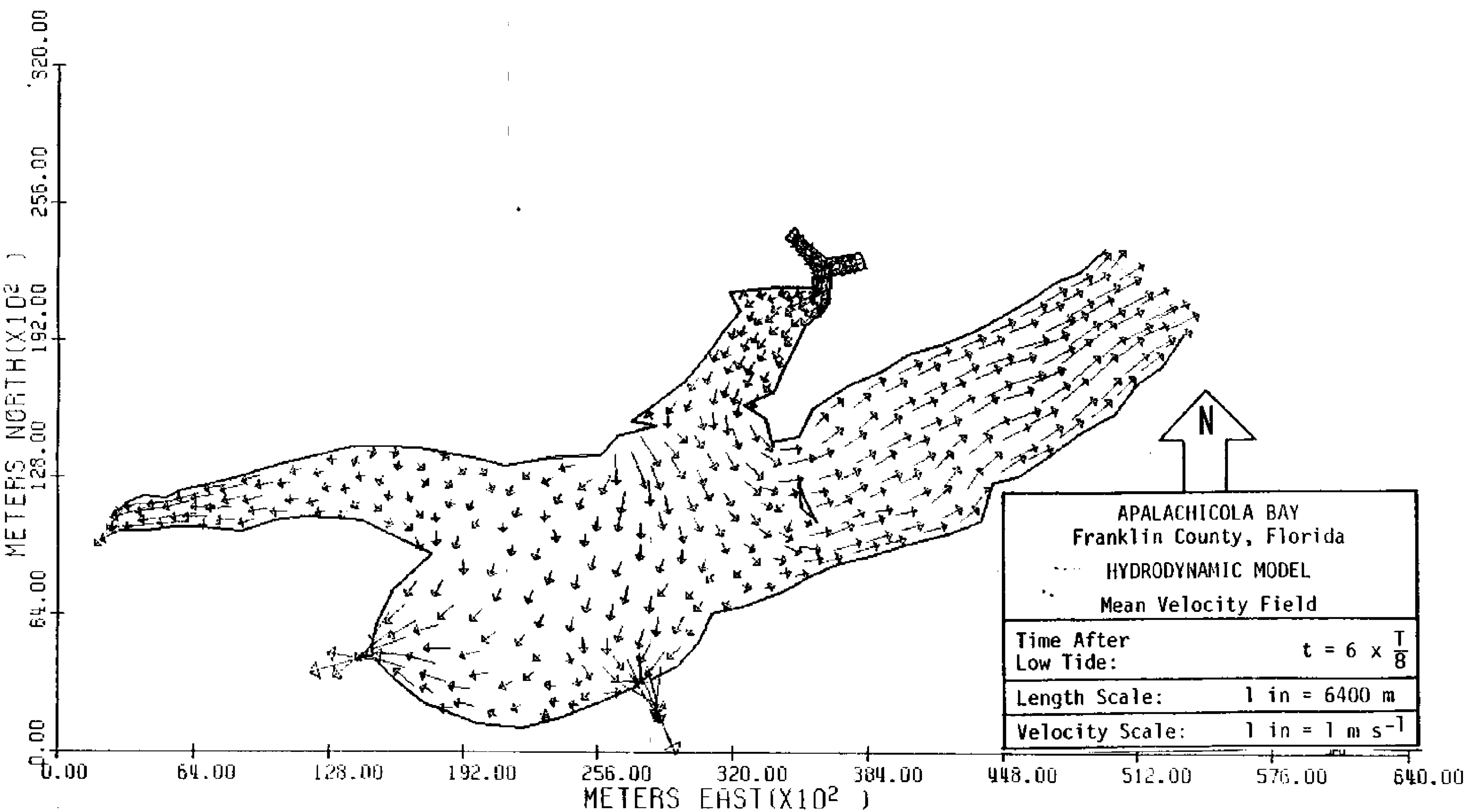


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 4 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

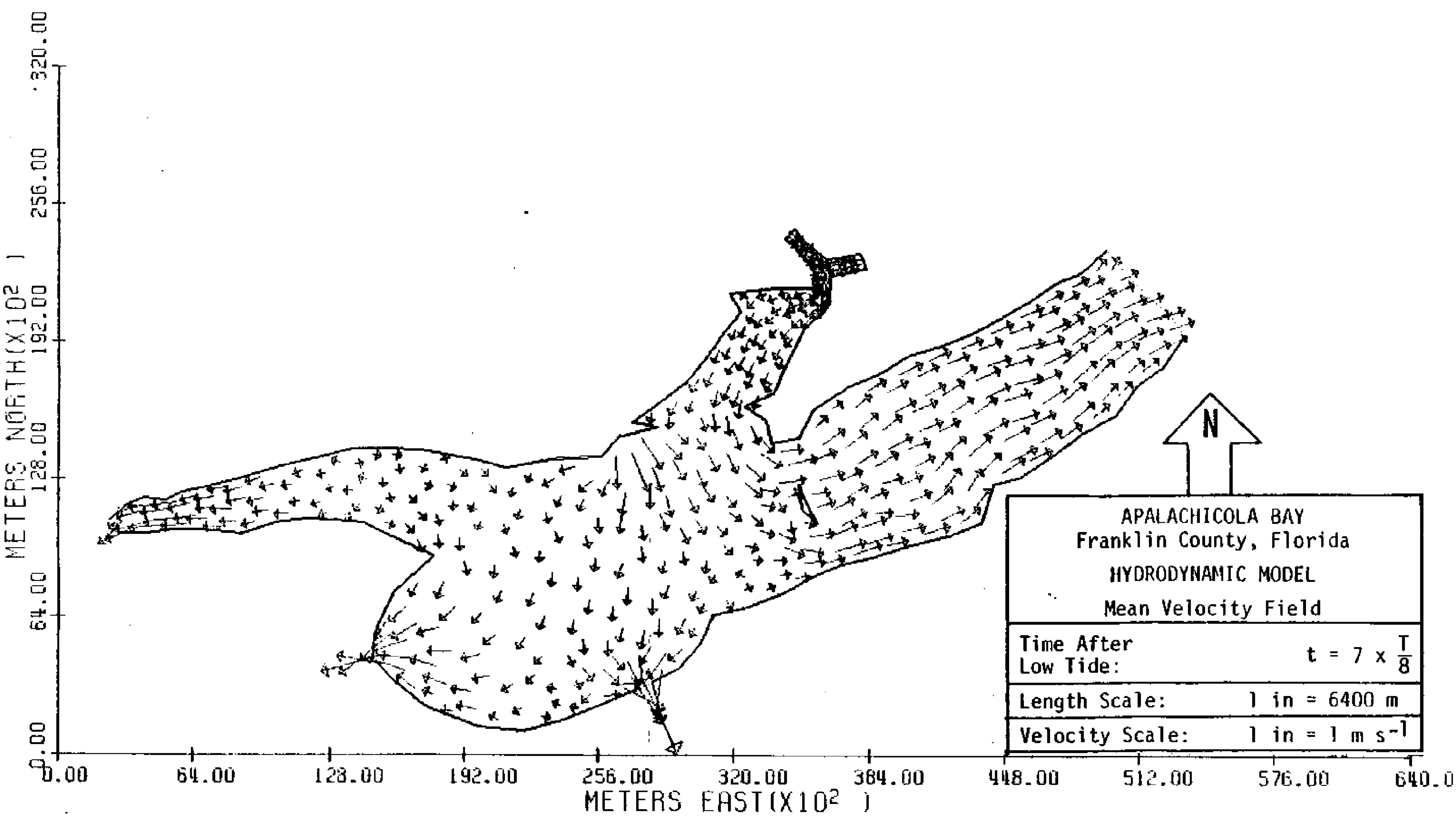
JUN 5


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide:
t = 5 x T/8
Length Scale:
1 in = 6400 m
Velocity Scale:
1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

JUN 6

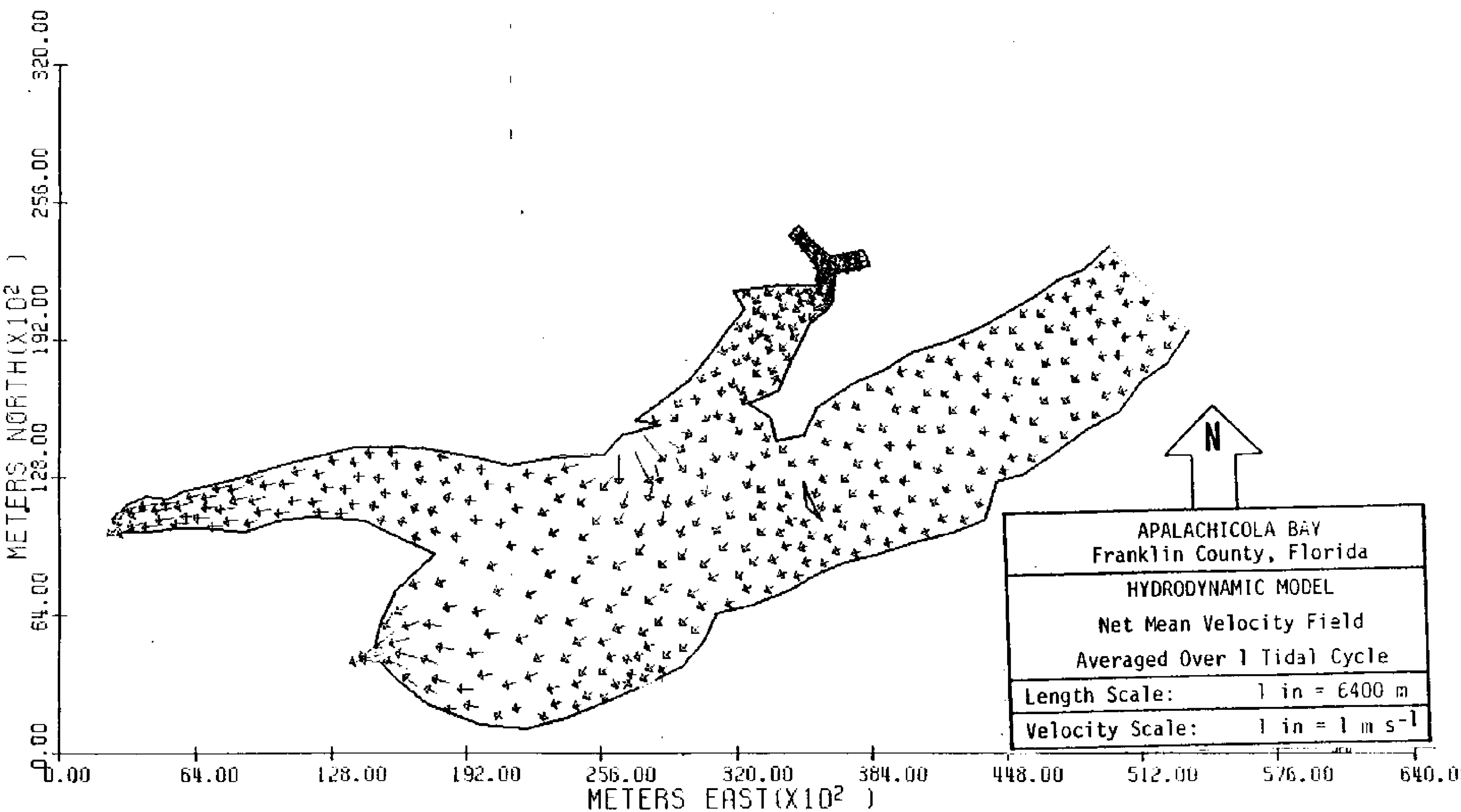

APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide:
t = 6 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

JUN 7

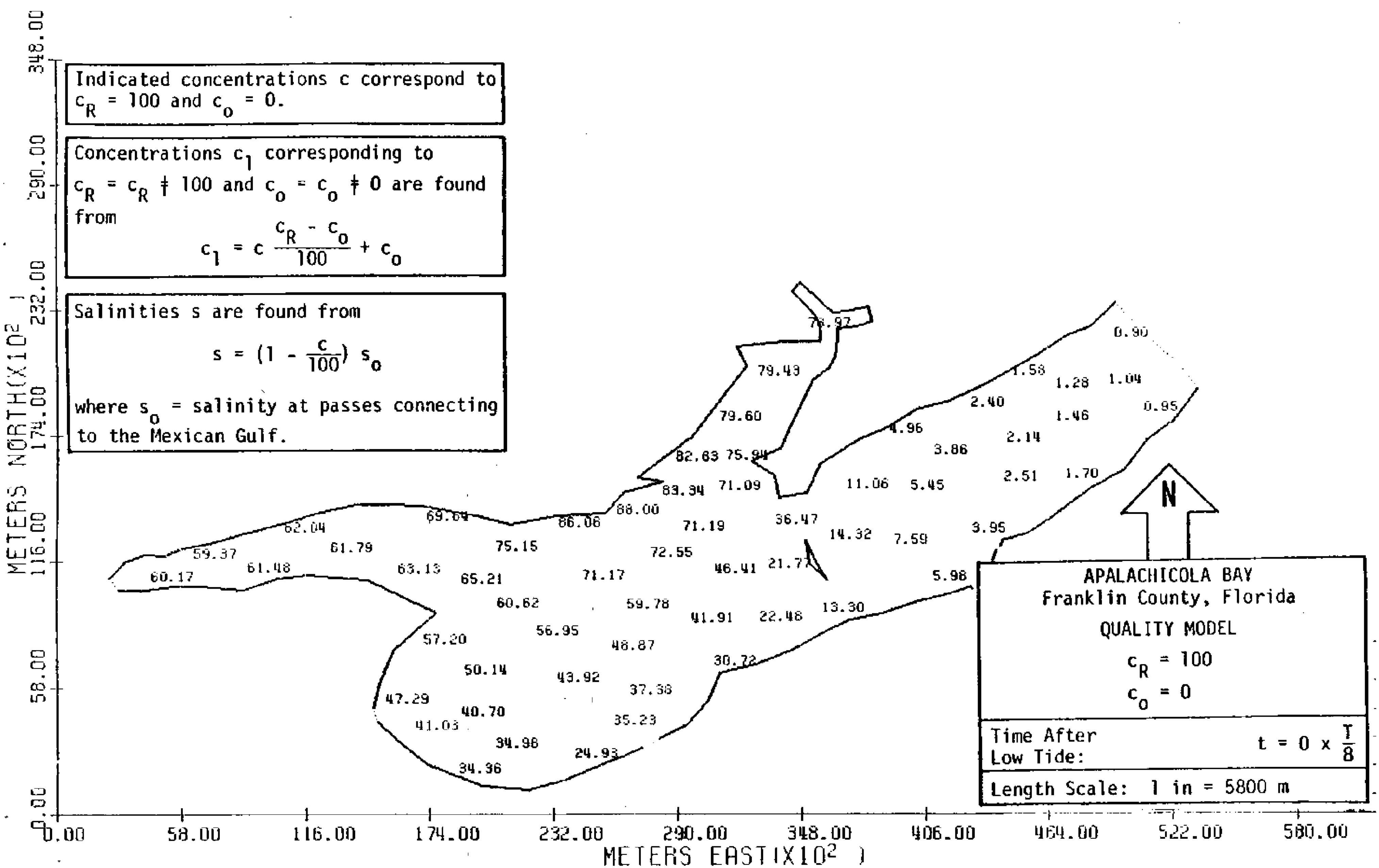


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 7 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH($X10^2$)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST($X10^2$)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

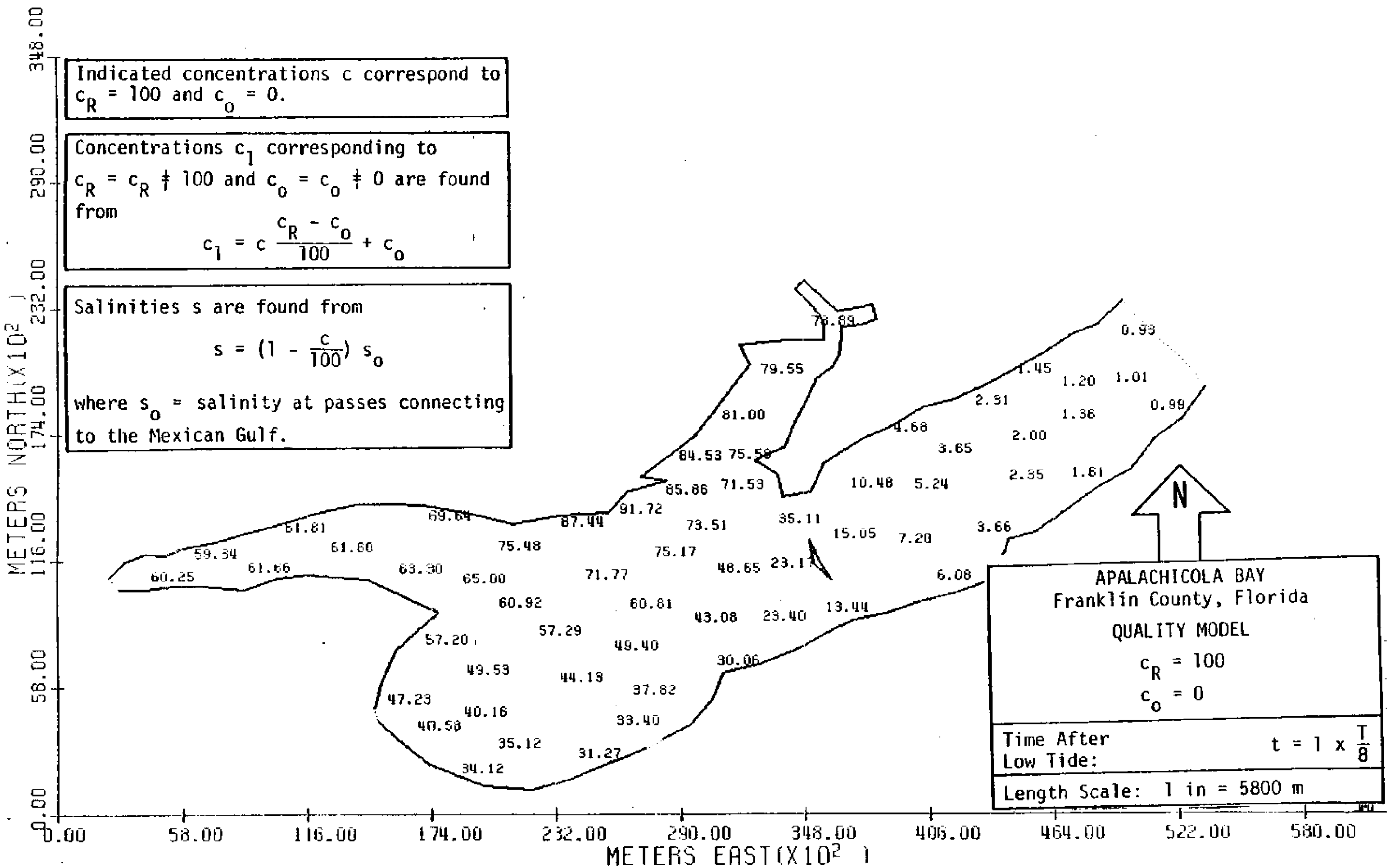
JUN 8


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Net Mean Velocity Field
Averaged Over 1 Tidal Cycle
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

JUN 9


Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c\,\frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = \left(1 - \frac{c}{100}\right) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide: $t = 0 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
60.17
59.37
61.48
62.04
61.79
63.13
69.64
65.21
75.15
60.62
57.20
50.14
47.29
41.03
40.70
34.98
34.36
56.95
43.92
24.93
35.23
37.38
48.87
59.78
71.17
86.06
88.00
72.55
71.19
83.94
71.09
82.63
75.94
79.60
79.43
76.97
46.41
41.91
22.48
21.77
36.47
30.72
13.30
14.32
11.06
7.59
5.45
5.98
3.95
3.86
4.96
2.51
2.14
2.40
1.70
1.46
1.58
1.28
1.04
0.90
0.95

JUN 10



Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide:
$t = 1 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00

JUN 11

Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.

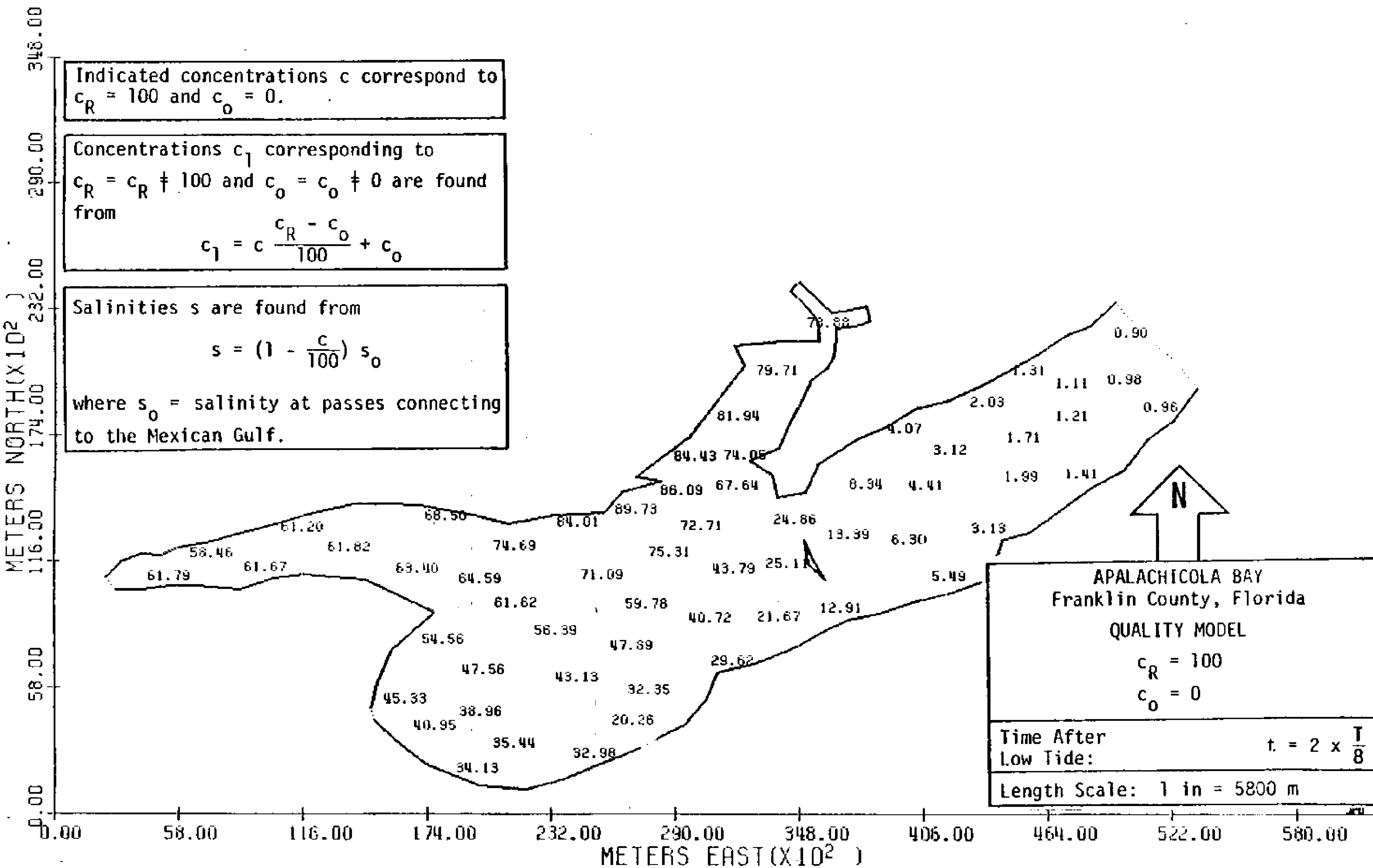
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from

$$c_1 = c\,\frac{c_R - c_o}{100} + c_o$$

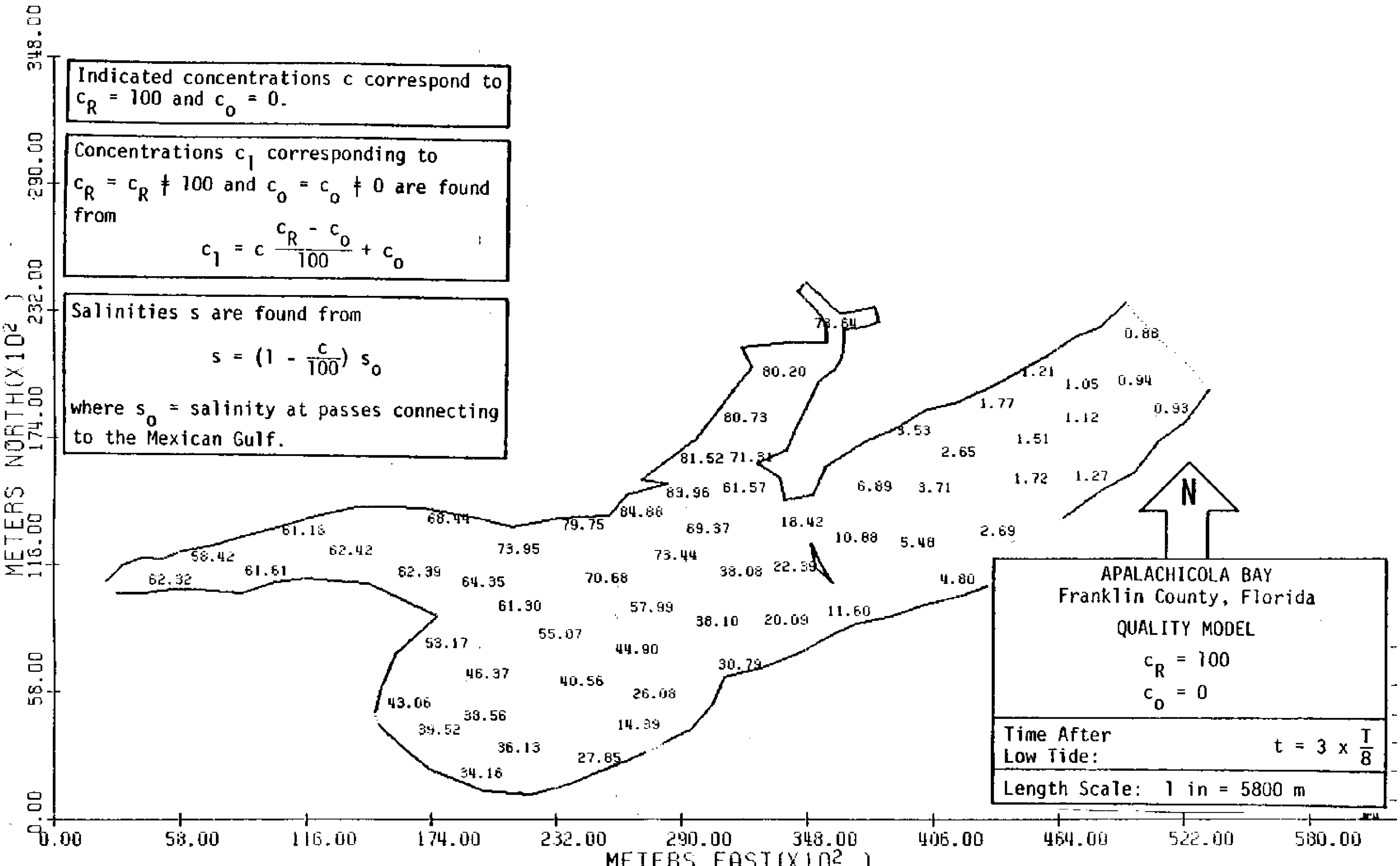
Salinities s are found from

$$s = \left(1 - \frac{c}{100}\right) s_o$$

where s_o = salinity at passes connecting to the Mexican Gulf.

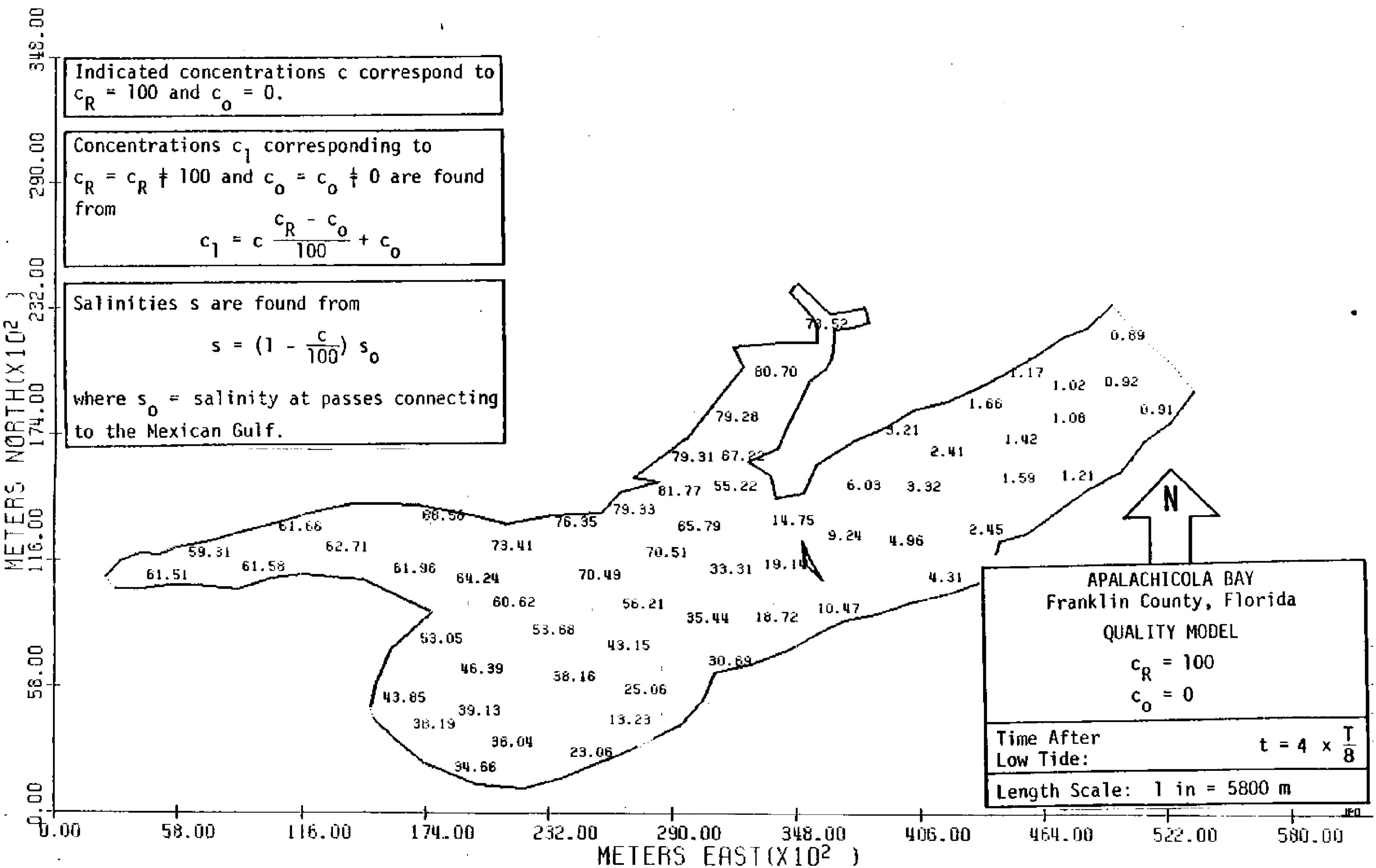


JUN 12



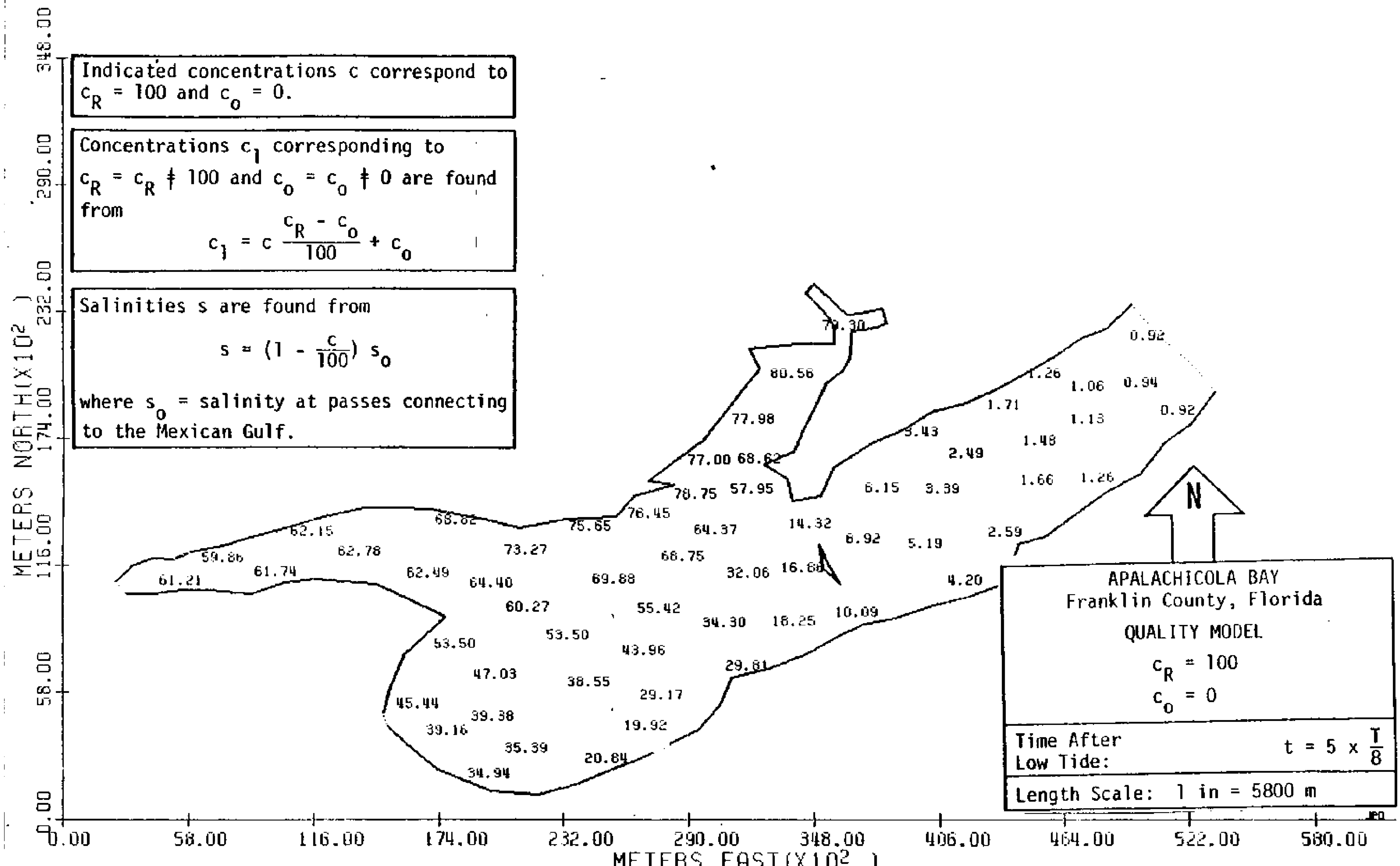
Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c\,\frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = \left(1 - \frac{c}{100}\right) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
N
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide: $t = 3 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00

JUN 13

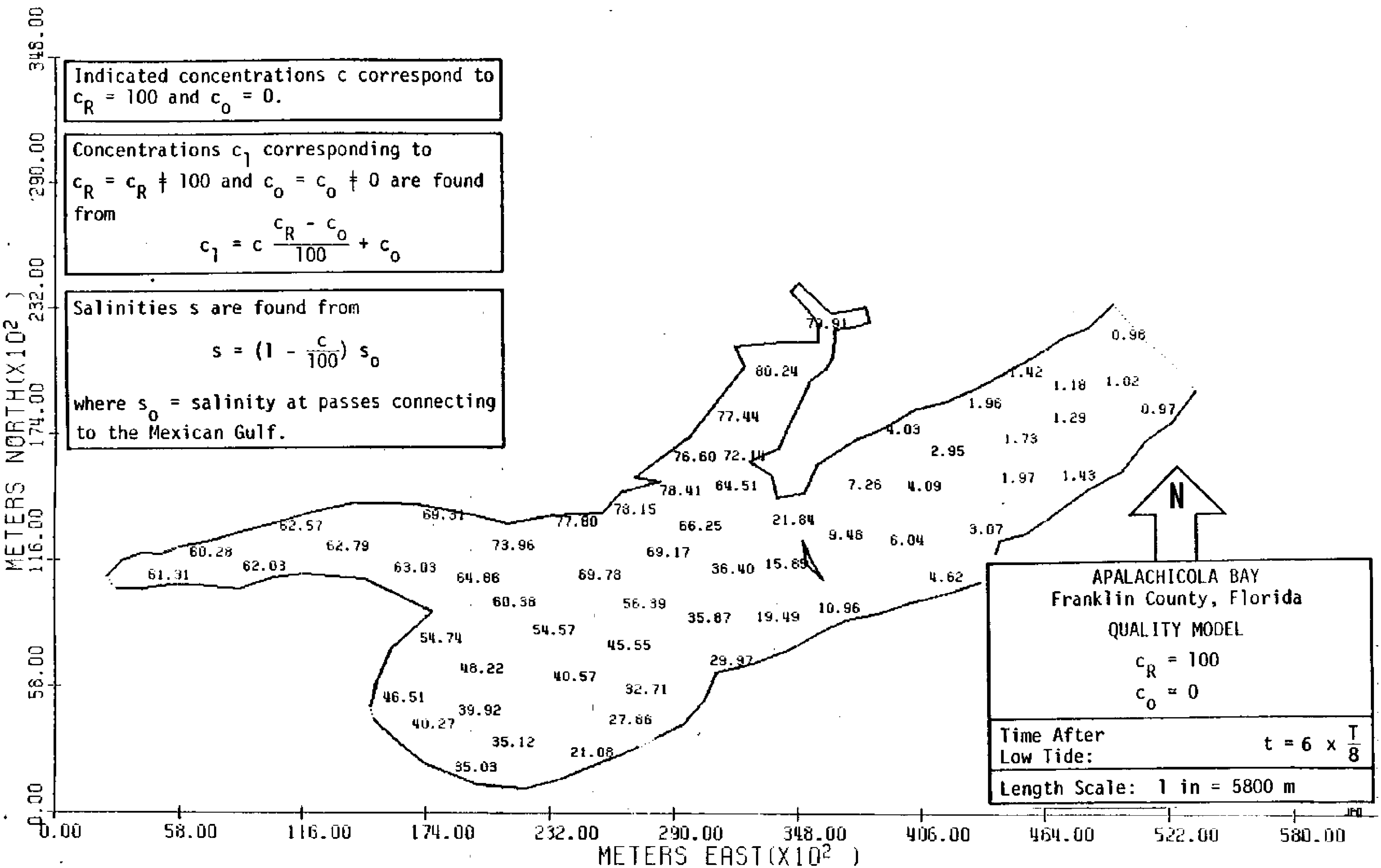


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100})\, s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 4 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
61.51
59.31
61.58
61.66
62.71
61.96
68.56
64.24
73.41
60.62
53.05
46.39
43.85
38.19
39.13
36.04
34.66
76.35
70.49
53.68
58.16
23.06
13.23
25.06
43.15
56.21
70.51
79.33
65.79
81.77
79.31
67.22
55.22
79.28
80.70
33.31
35.44
30.68
18.72
19.14
14.75
10.47
9.24
6.03
3.32
4.96
4.31
2.45
2.41
3.21
1.66
1.42
1.59
1.17
1.02
1.08
1.21
0.92
0.91
0.89

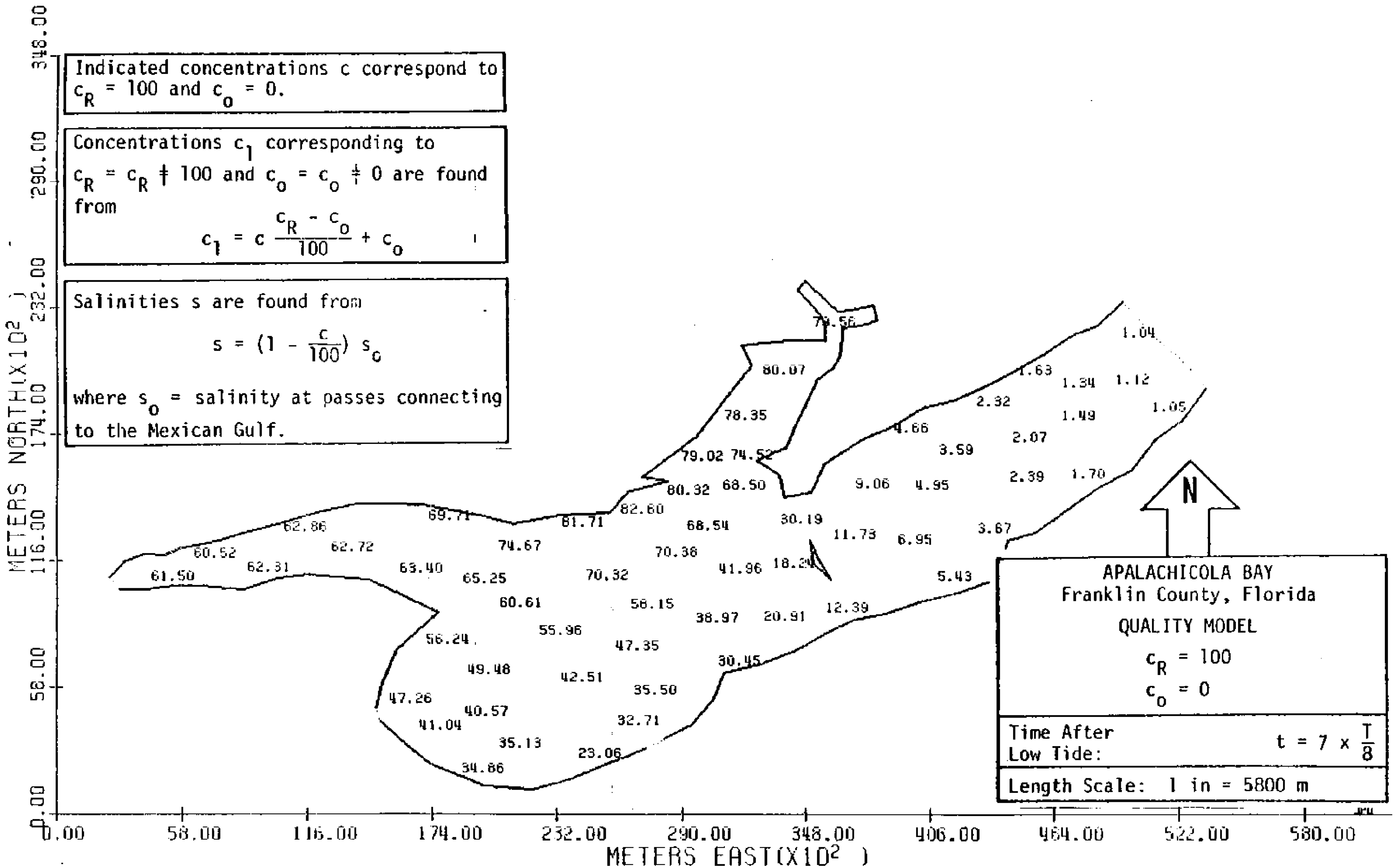
JUN 14


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c \frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = (1 - \frac{c}{100}) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide:
$t = 5 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
61.21
59.86
61.74
62.15
62.78
68.82
62.49
64.40
73.27
60.27
53.50
47.03
45.44
39.16
39.38
35.39
34.94
75.65
69.88
53.50
38.55
20.84
76.45
78.75
77.00
68.62
77.98
80.56
57.95
64.37
66.75
55.42
43.96
29.17
19.92
32.06
34.30
29.81
14.32
16.68
18.25
10.09
6.15
6.92
3.43
3.39
5.19
2.49
1.71
1.48
1.66
2.59
4.20
1.26
1.06
1.13
1.26
0.94
0.92
0.92

JUN 15


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c\,\frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = \left(1 - \frac{c}{100}\right) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide: $t = 6 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
61.31
60.28
62.03
62.57
62.79
63.03
69.31
64.86
73.96
60.38
77.80
69.78
54.74
54.57
48.22
46.51
40.27
39.92
40.57
35.12
35.03
21.08
27.86
32.71
45.55
56.39
69.17
78.15
78.41
76.60
72.14
77.44
80.24
79.91
64.51
66.25
36.40
35.87
29.97
19.49
15.89
21.84
10.96
9.48
7.26
6.04
4.09
4.03
4.62
2.95
3.07
1.96
1.73
1.97
1.42
1.18
1.29
1.43
0.96
1.02
0.97

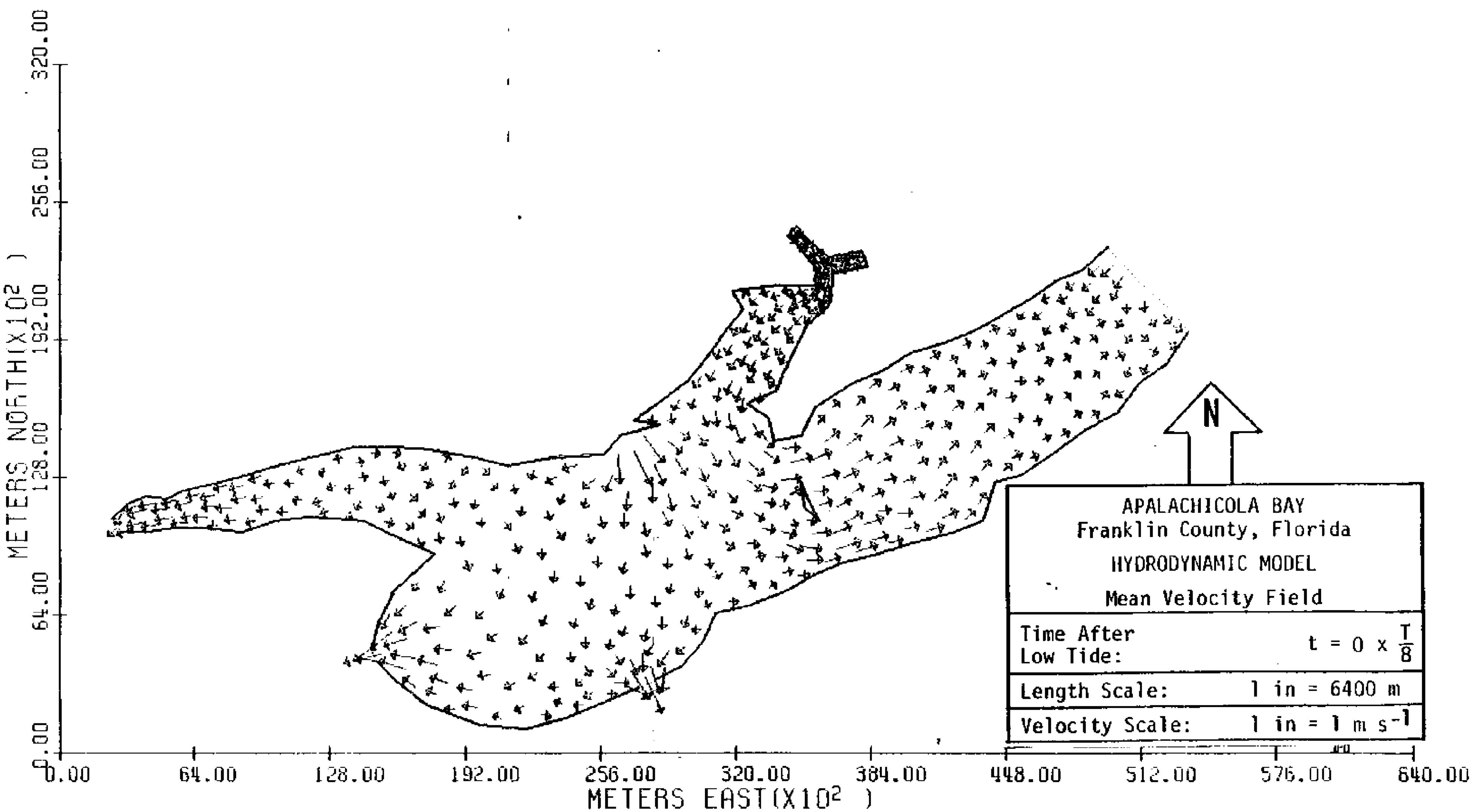
JUN 16


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100})\, s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 7 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS EAST(X10²)
METERS NORTH(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
61.50
60.52
62.31
62.86
62.72
63.40
69.71
65.25
74.67
60.61
56.24
49.48
47.26
41.04
40.57
35.13
34.86
55.96
42.51
81.71
70.32
82.60
80.32
79.02
74.52
78.35
80.07
68.50
68.54
70.36
58.15
47.35
35.50
32.71
23.06
38.97
41.96
30.45
20.91
18.24
30.19
12.39
11.73
9.06
6.95
4.95
5.43
4.66
3.59
3.67
2.32
2.07
2.39
1.63
1.34
1.49
1.70
1.04
1.12
1.05

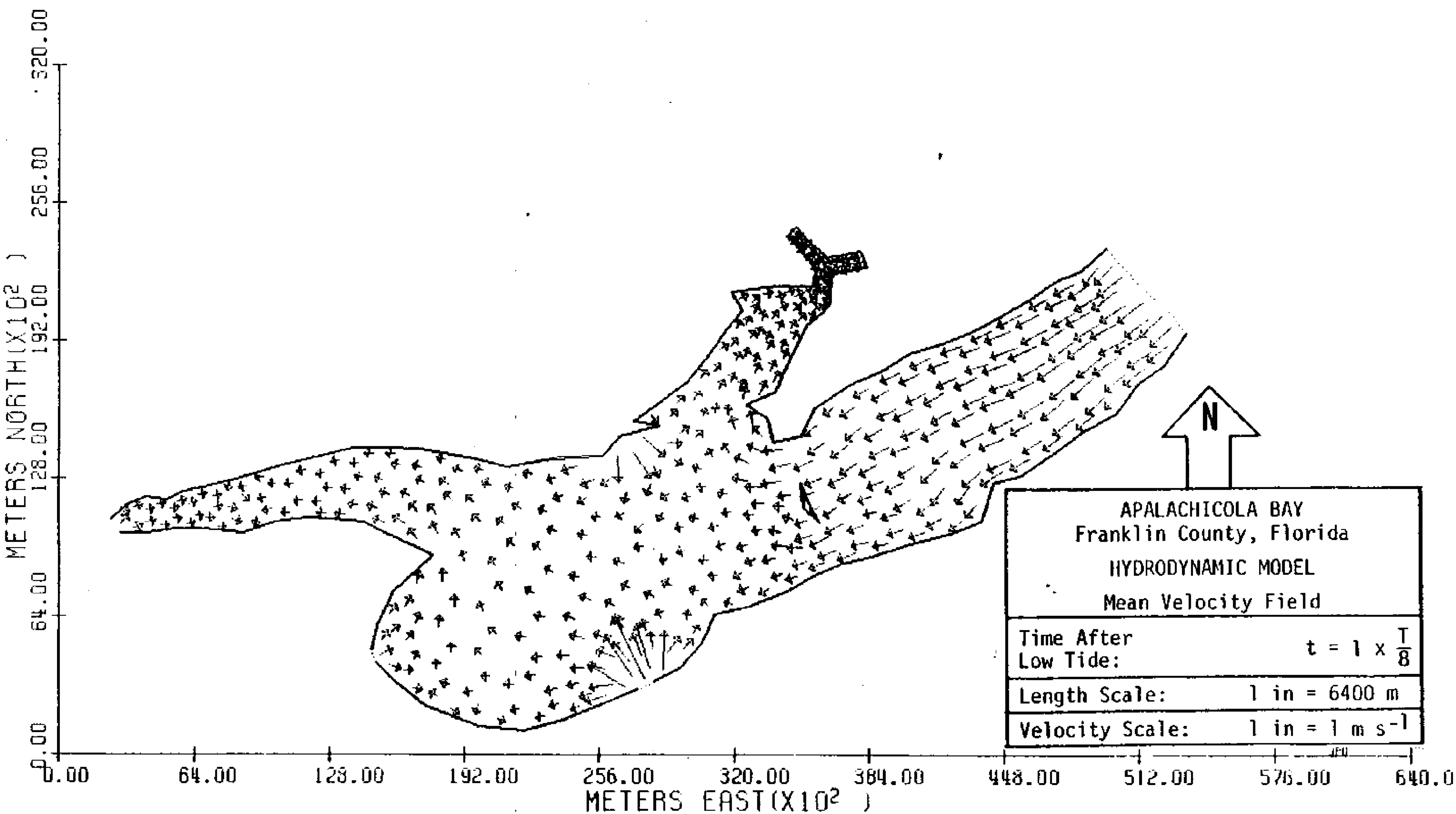
JUN 17

JULY

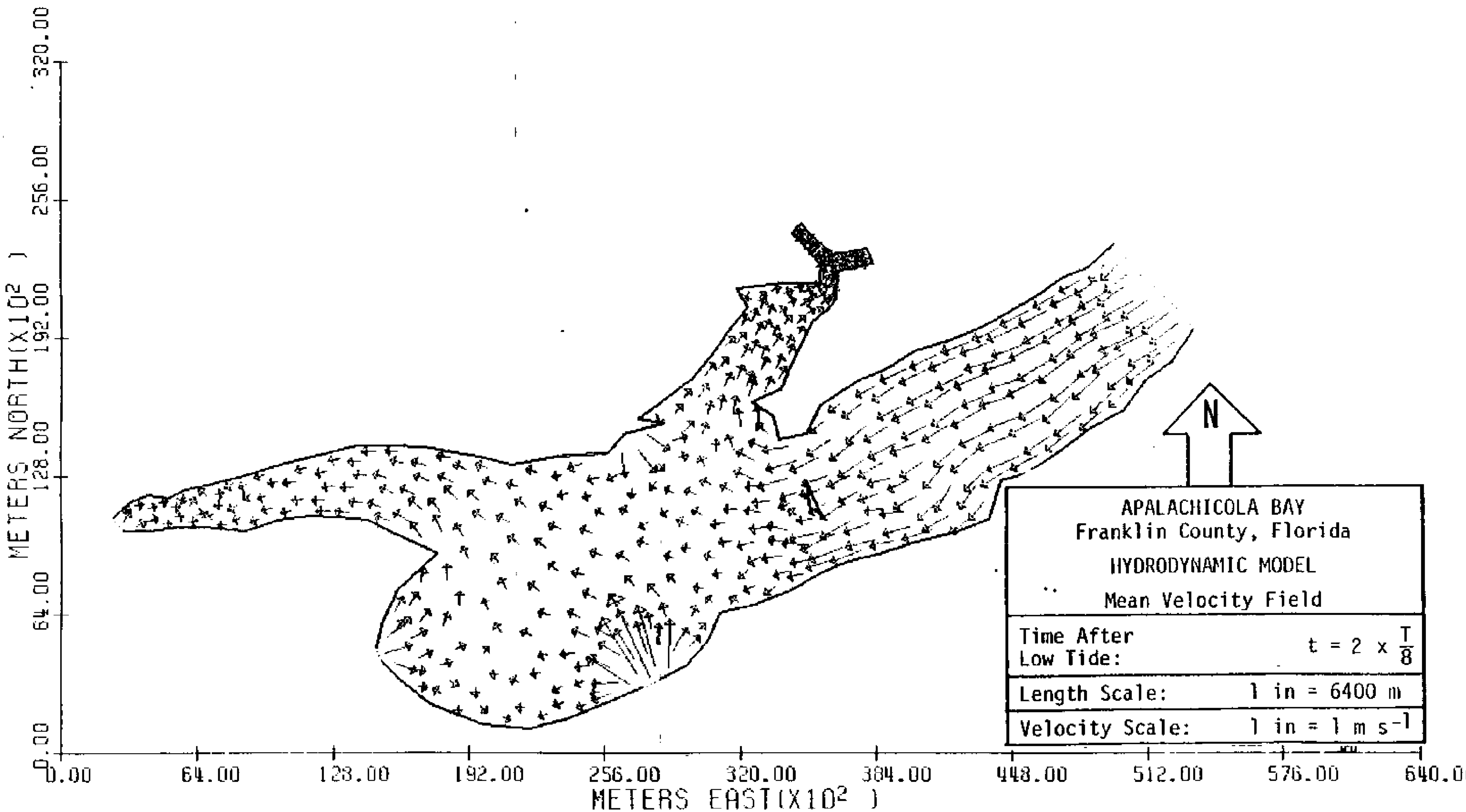
JUL 1 through JUL 8:	Vertically averaged velocities v_m given at time increments equal to one eighth of the tidal period beginning at low tide.
JUL 9:	Net values of vertically averaged velocities. Time averaged over one tidal cycle.
JUL 10 through JUL 17:	Vertically averaged pollutant concentration corresponding to river concentration c_R = 100 and concentration c_o = 0 at all inlets to bay. Concentrations given at time increments equal to one eighth of the tidal period beginning at low tide.


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 0 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

JUL 1

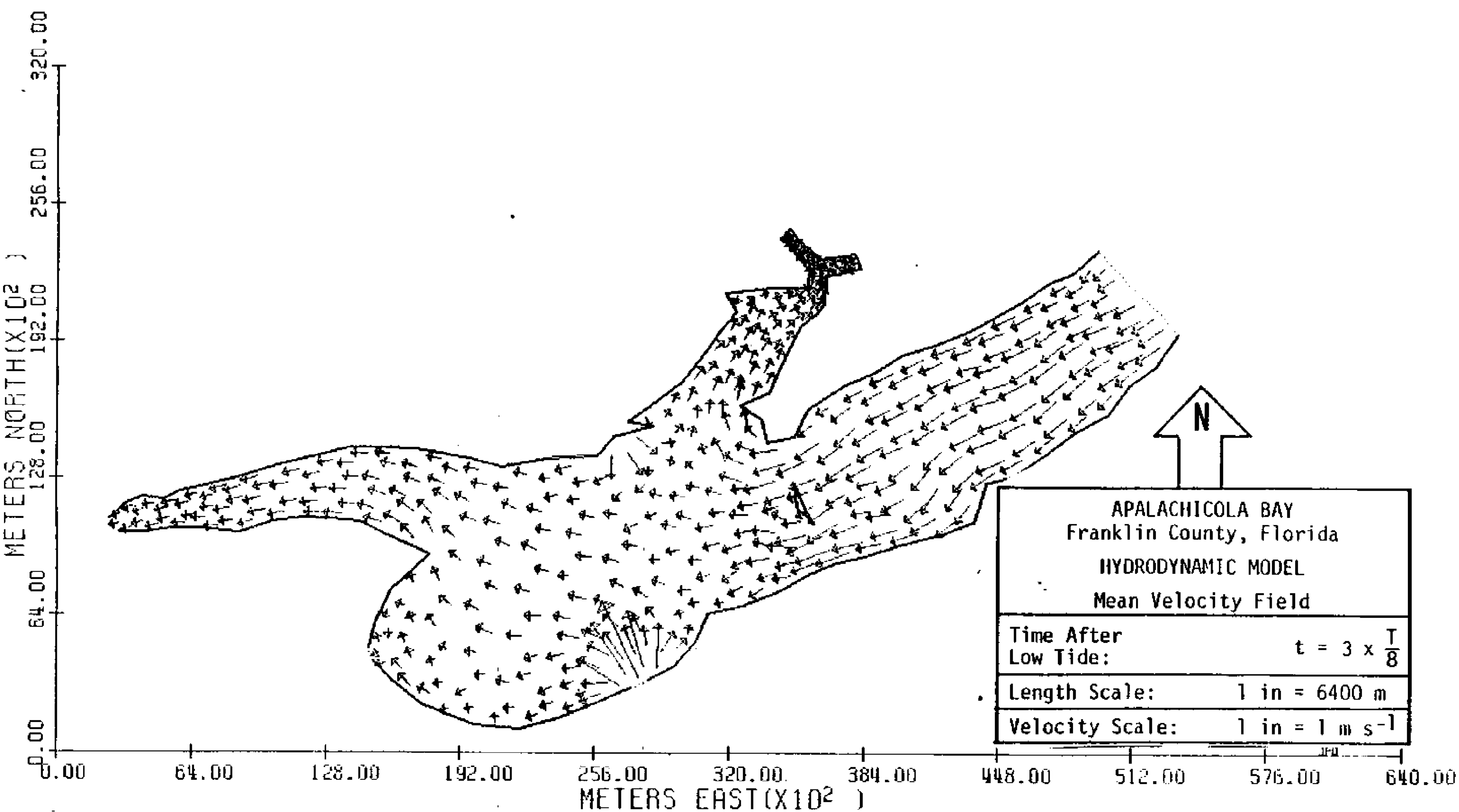

APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 1 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^-1
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

JUL 2

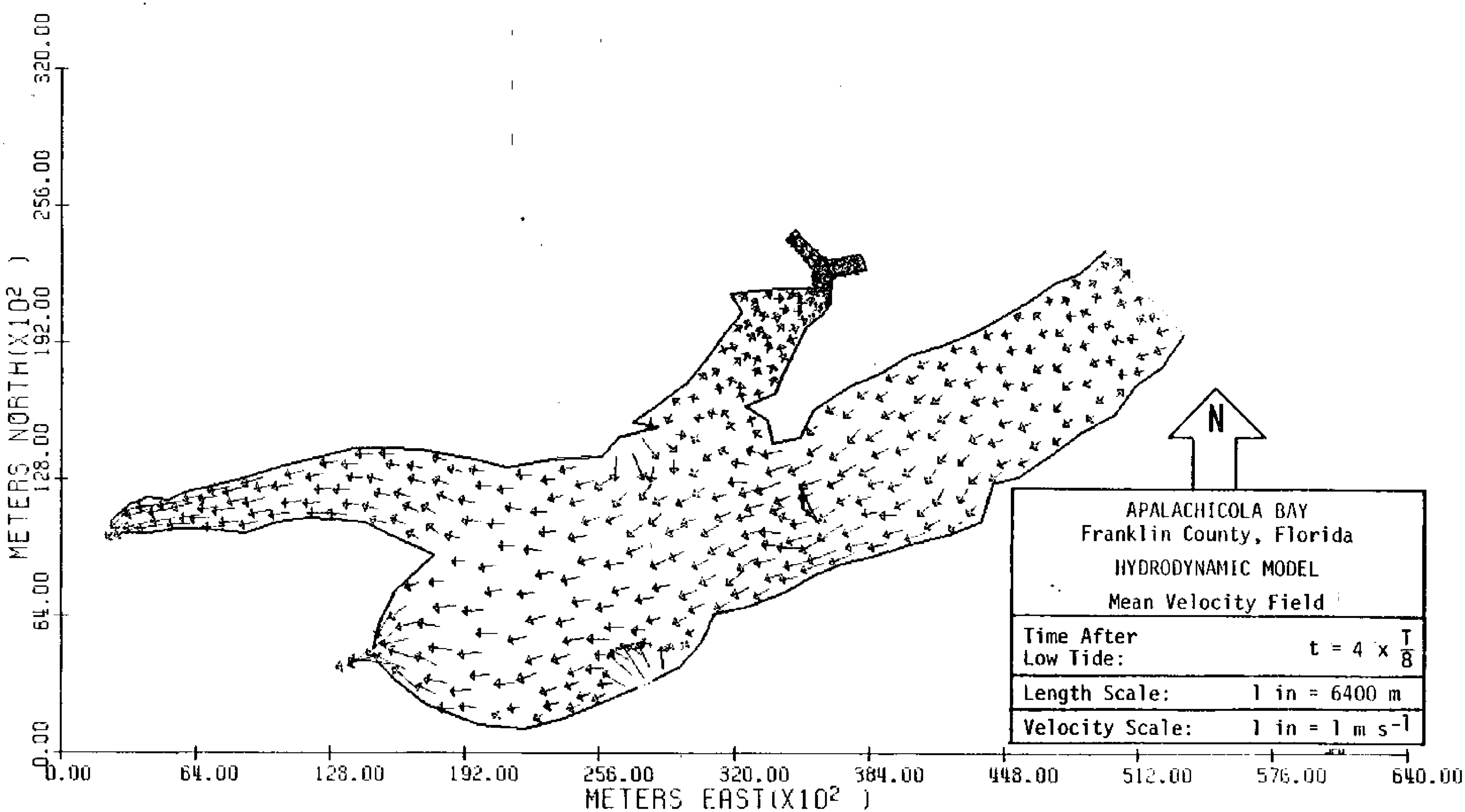


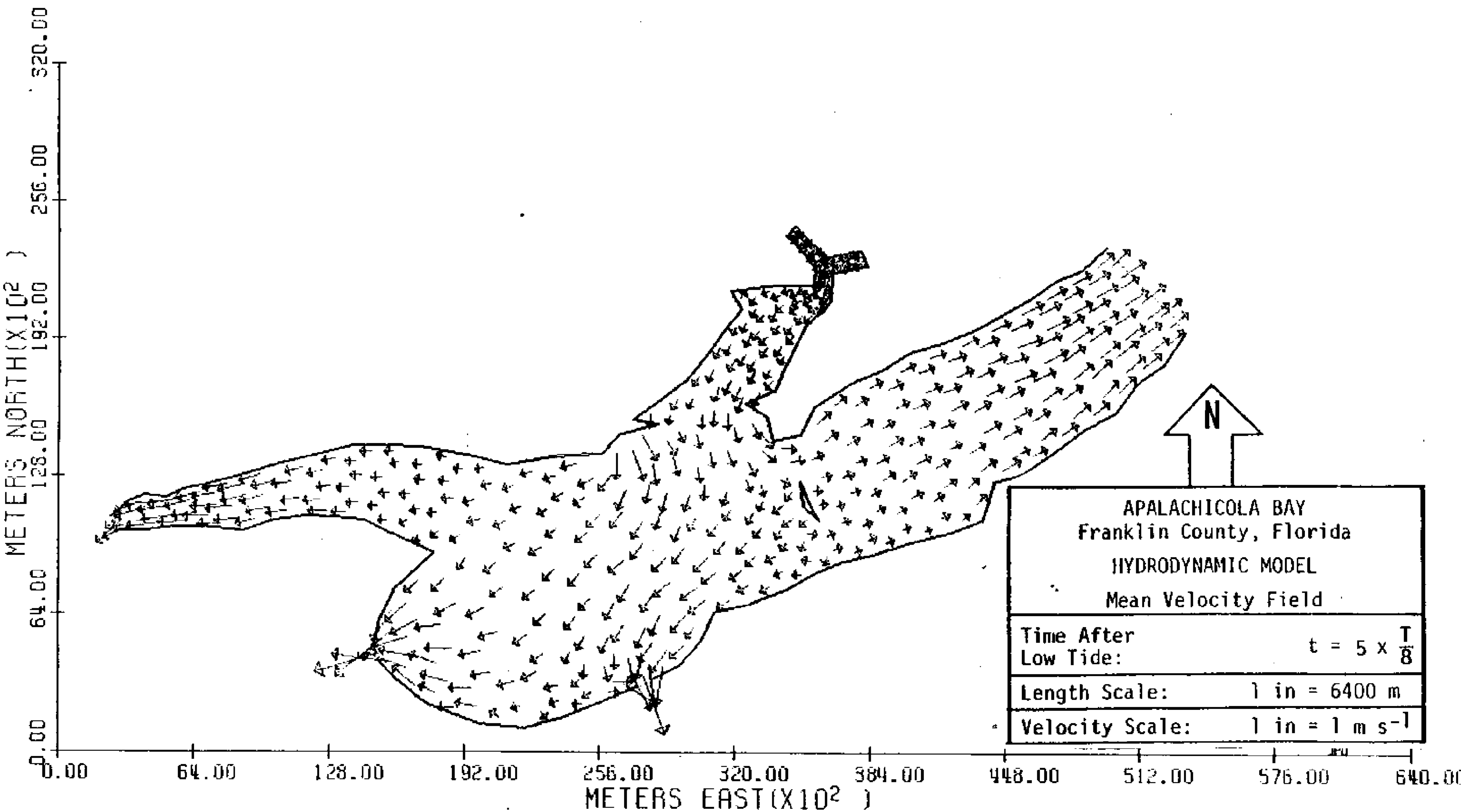
APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 2 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH($X10^2$)
METERS EAST($X10^2$)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

JUL 3


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 3 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

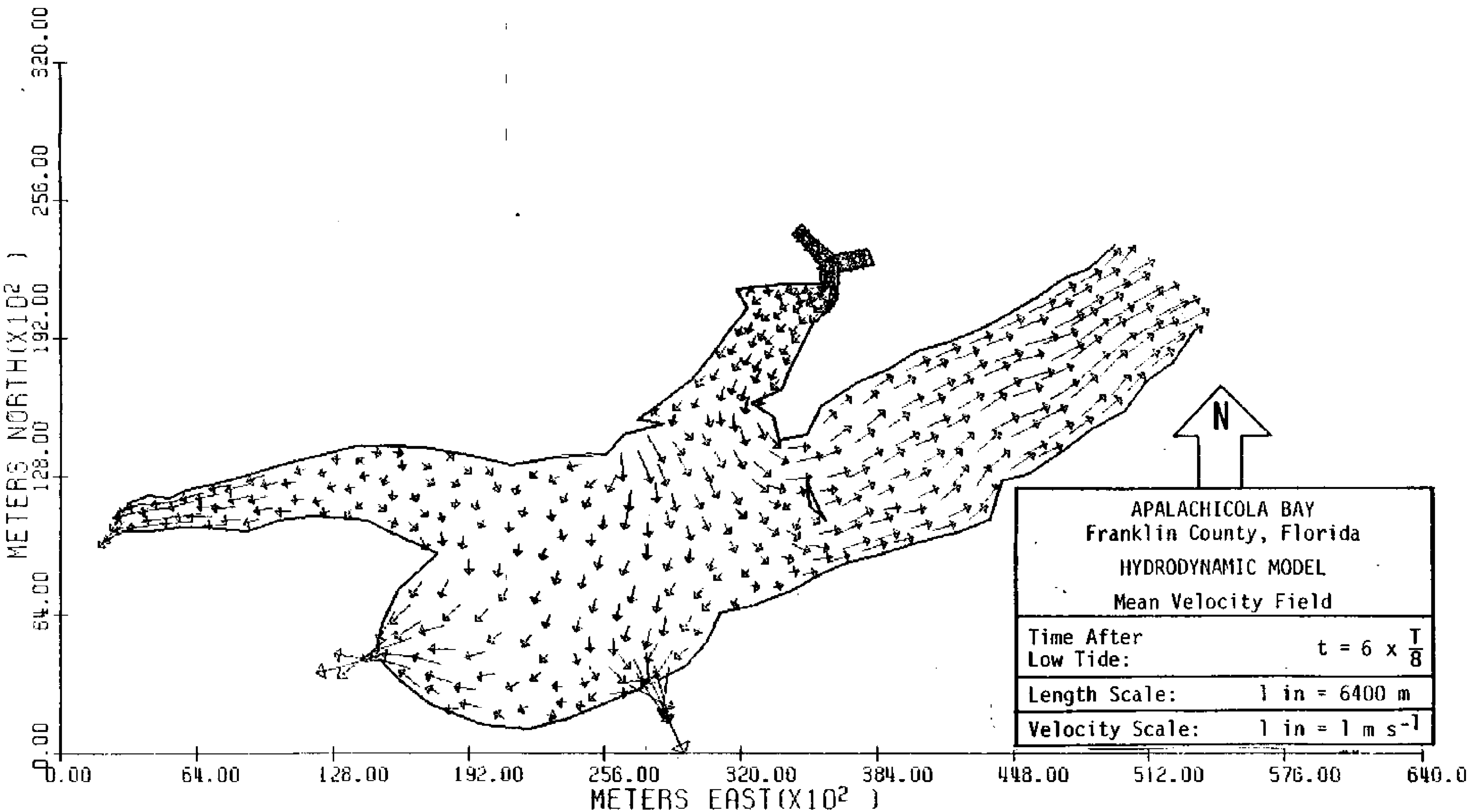
JUL 4


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 4 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00
JUL 5

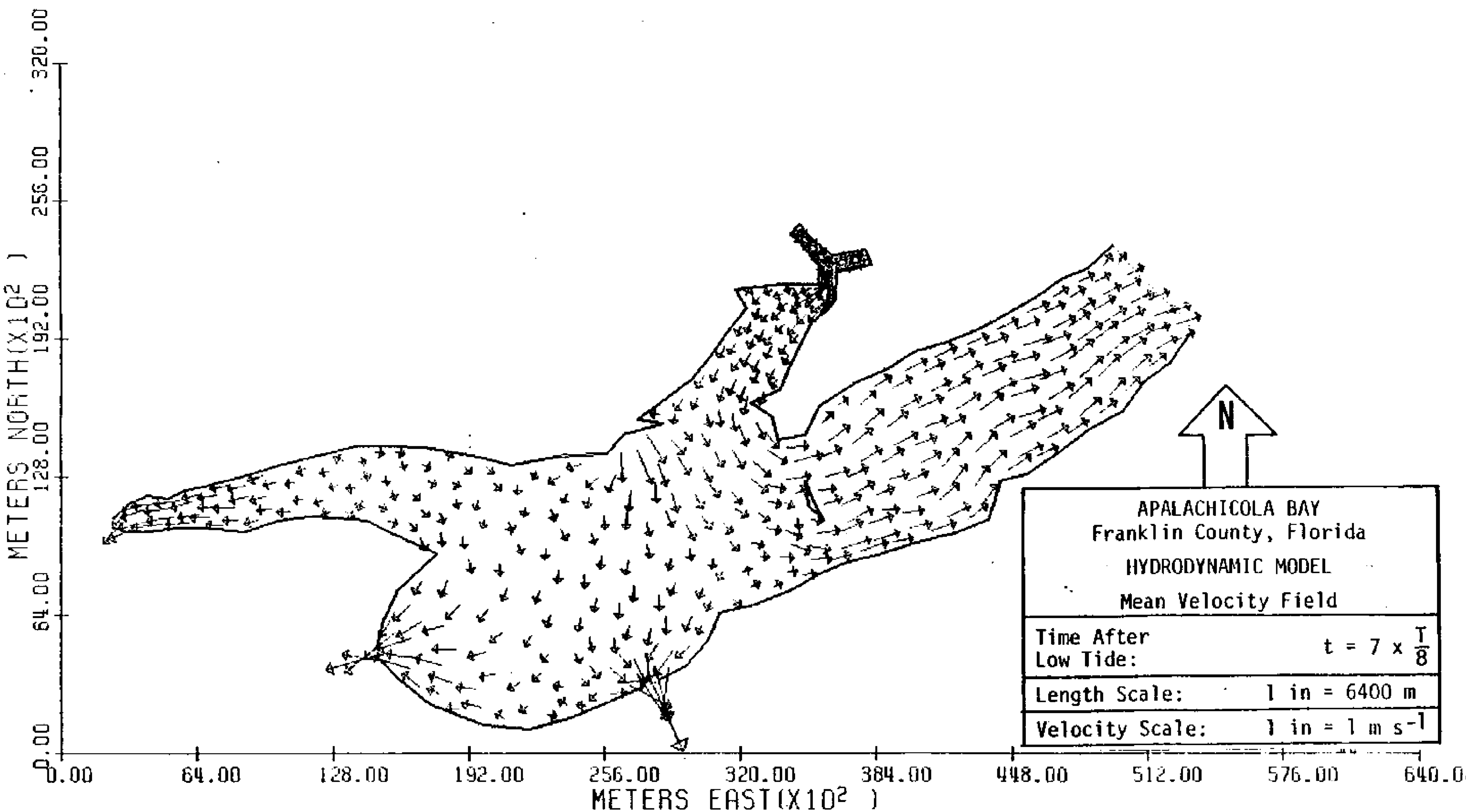


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 5 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH (X10^2)
METERS EAST (X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

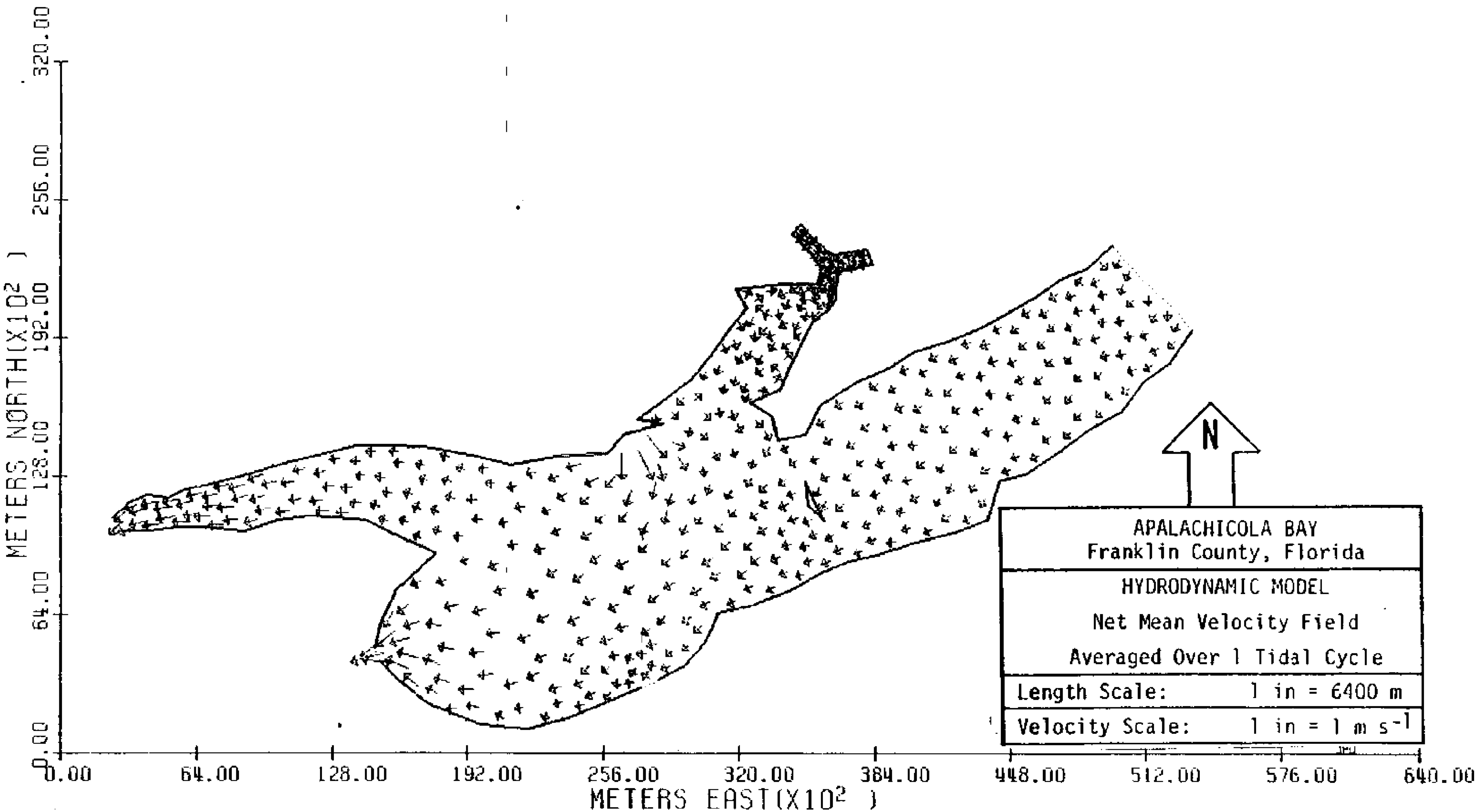
JUL 6


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide:
t = 6 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

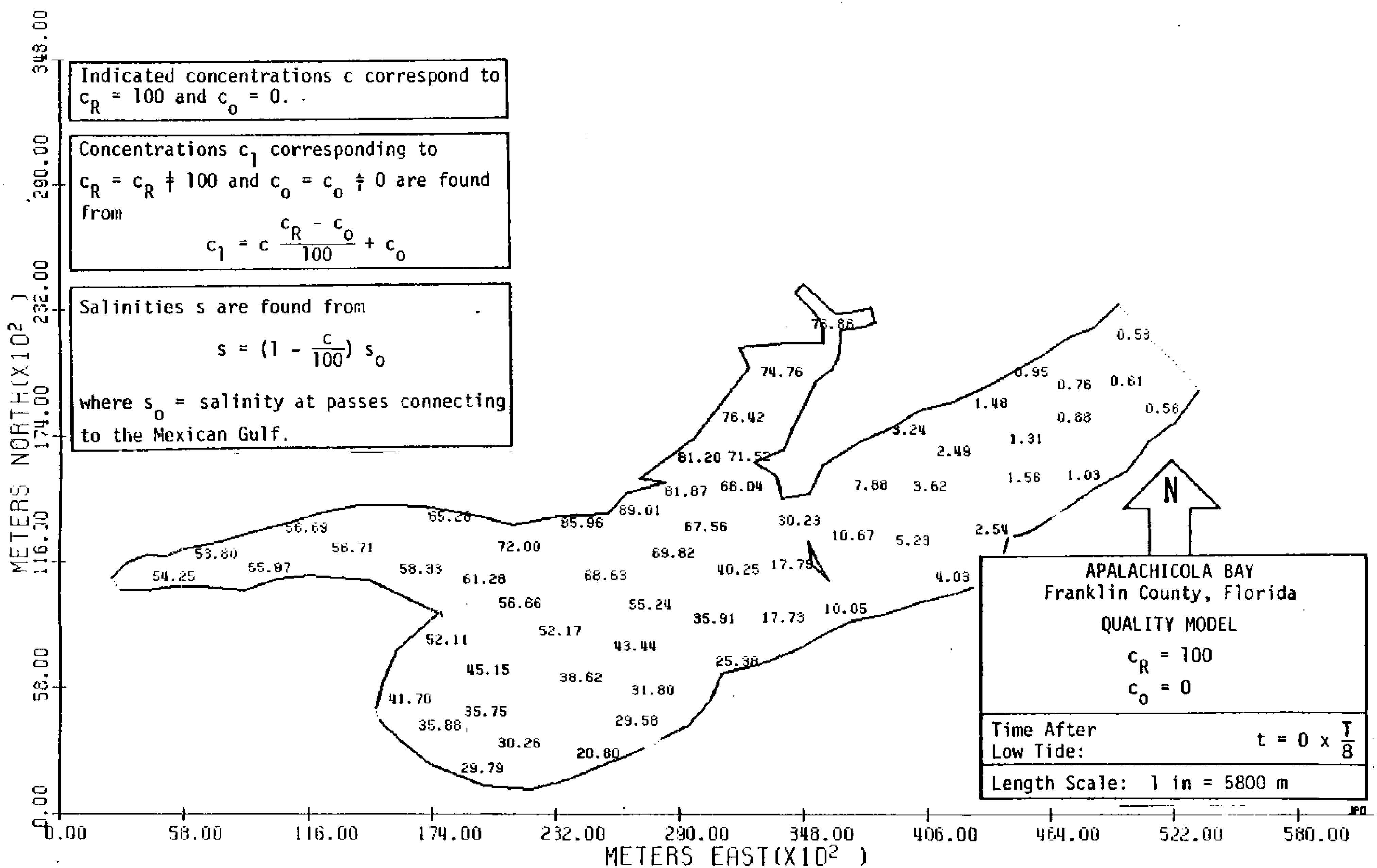
JUL 7


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide:
$t = 7 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

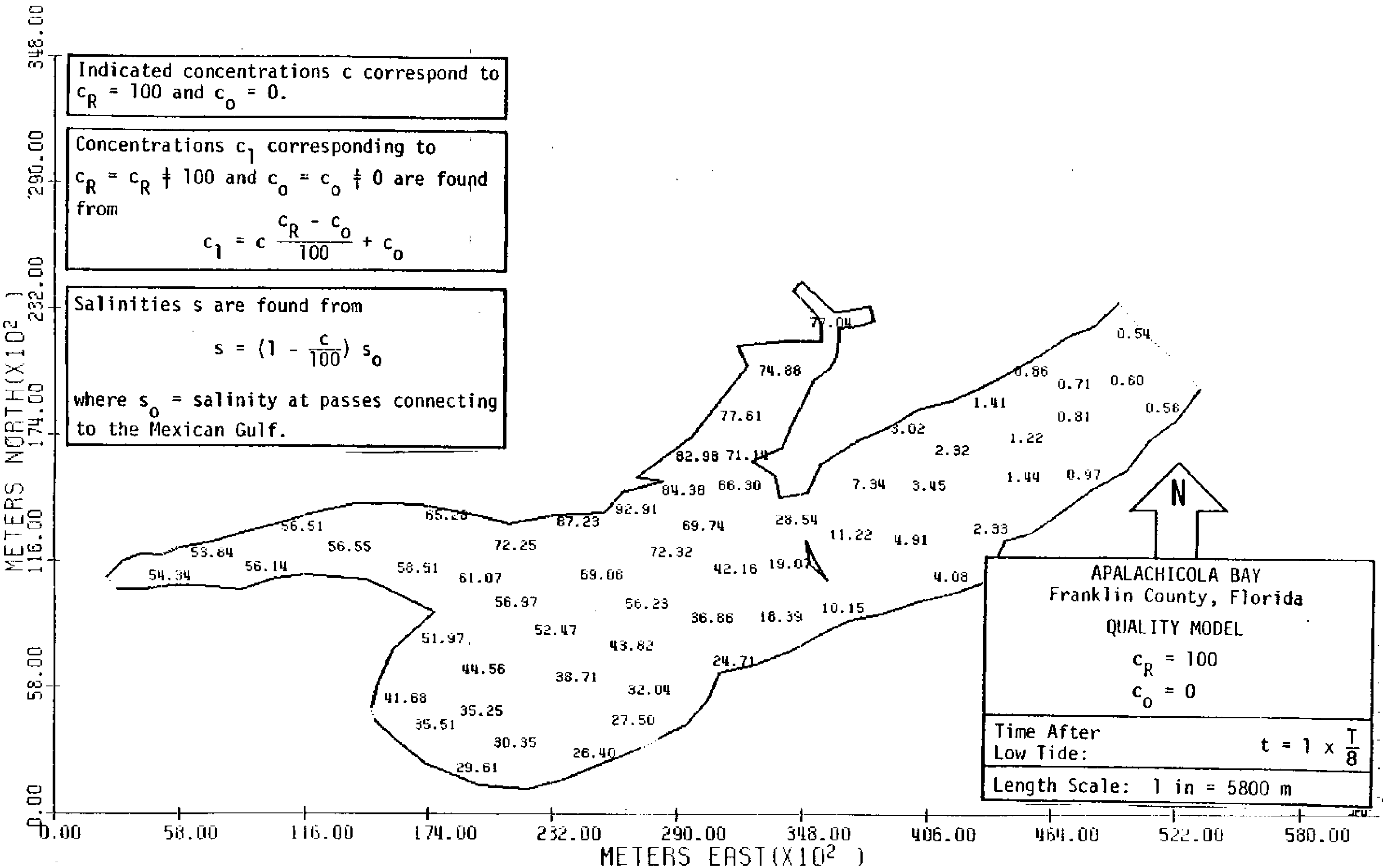
JUL 8


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Net Mean Velocity Field
Averaged Over 1 Tidal Cycle
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

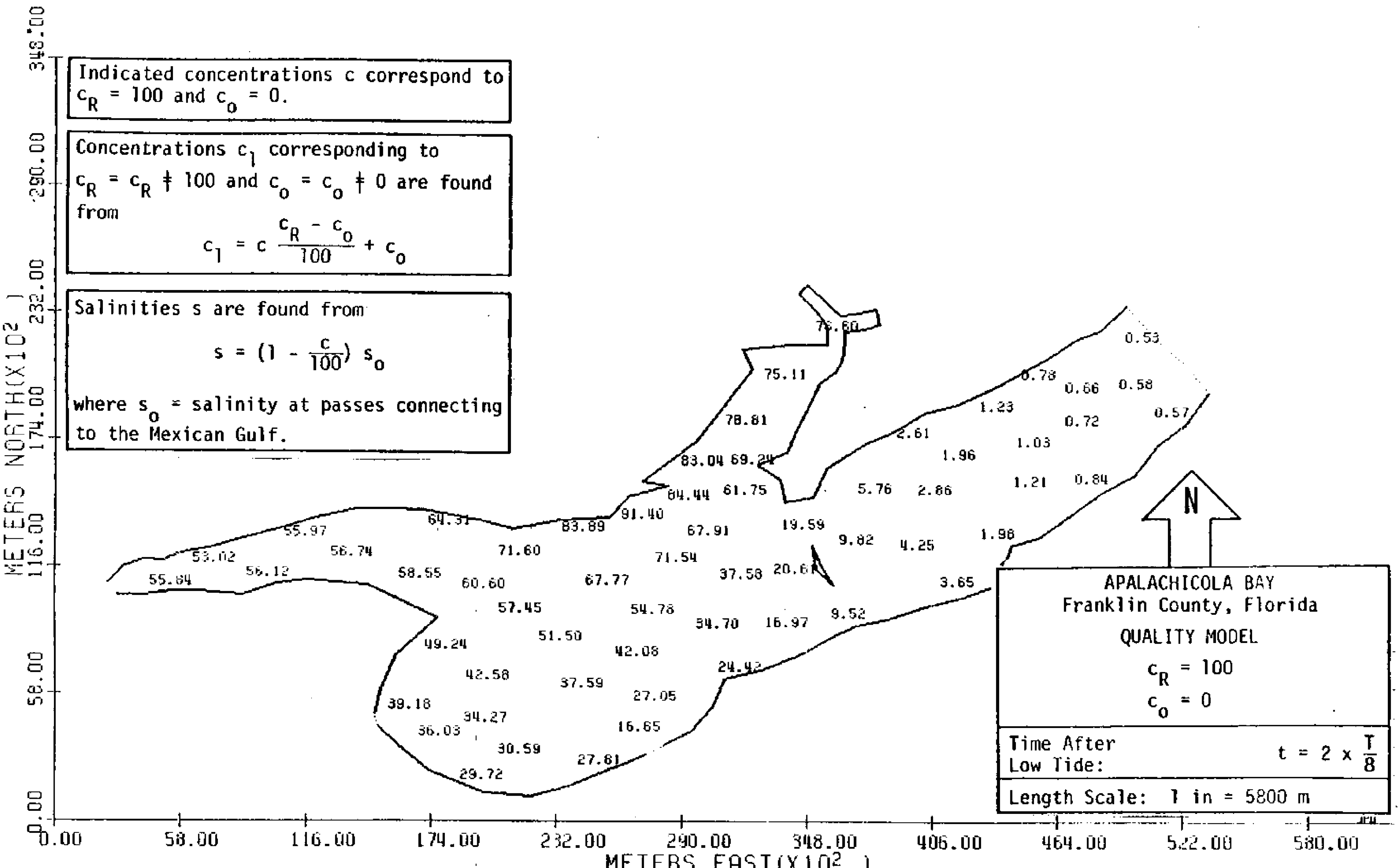
JUL 9


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 0 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00

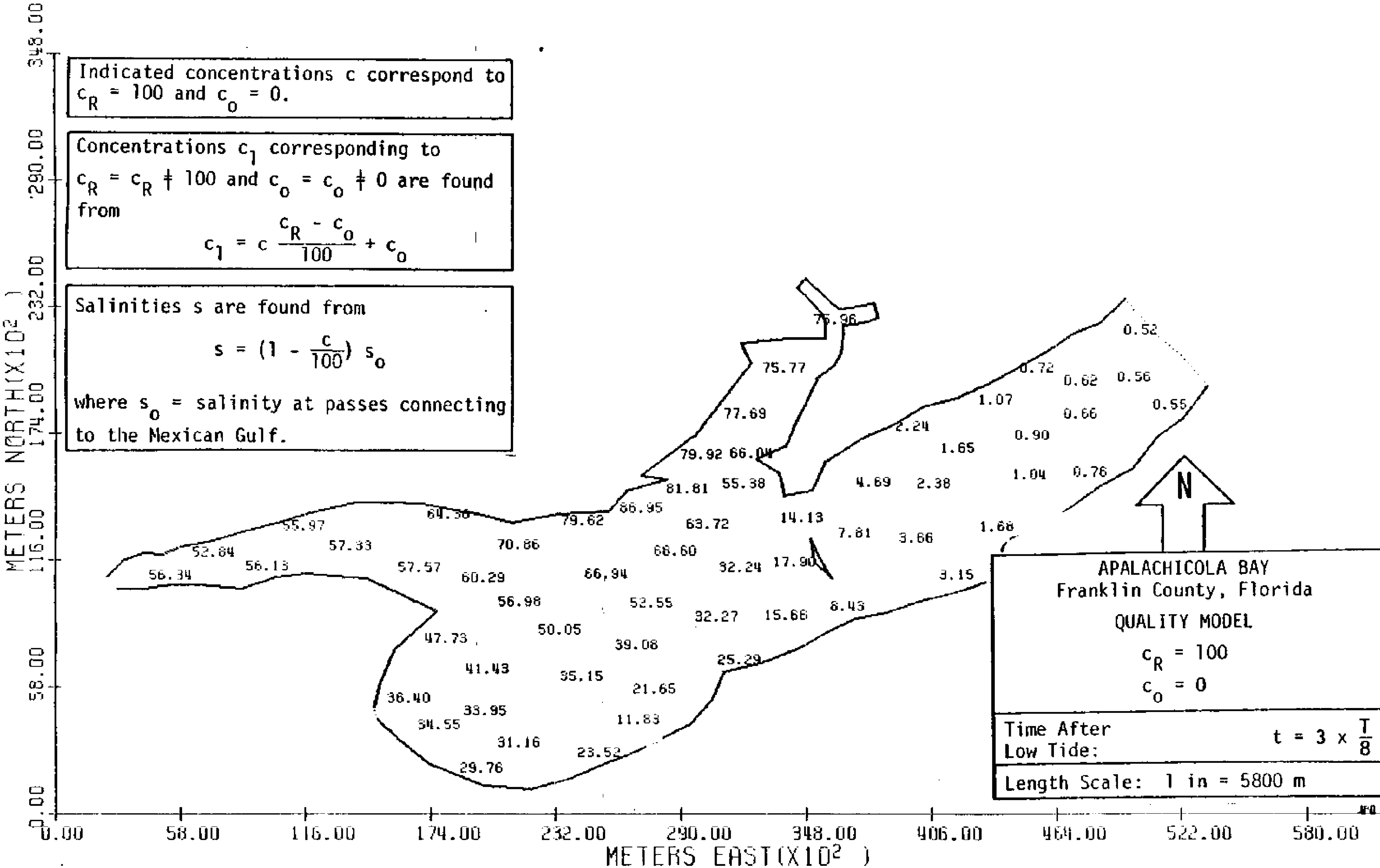
JUL 10


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 1 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
77.04
74.88
77.61
82.98
71.14
84.38
66.30
92.91
87.23
65.28
56.51
53.84
54.34
56.14
56.55
58.51
72.25
61.07
69.74
72.32
69.06
28.54
42.16
19.07
11.22
4.91
7.34
3.45
3.02
2.32
1.41
0.86
0.71
0.60
0.54
0.81
0.56
1.22
1.44
0.97
2.33
4.08
10.15
18.39
36.86
56.23
56.97
52.47
51.97
44.56
43.82
38.71
24.71
32.04
27.50
41.68
35.25
35.51
30.35
26.40
29.61

JUL 11


Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c\,\frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = \left(1 - \frac{c}{100}\right) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide:
$t = 2 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
0.53
0.78
0.66
0.58
1.23
0.72
0.57
2.61
1.96
1.03
5.76
2.86
1.21
0.84
19.59
9.82
4.25
1.98
3.65
20.6
9.52
16.97
37.58
34.70
24.42
7?.60
75.11
78.81
83.04
69.24
84.44
61.75
91.40
67.91
71.54
54.78
42.08
27.05
16.65
27.81
83.89
71.60
67.77
51.50
37.59
30.59
29.72
64.31
60.60
57.45
42.58
34.27
36.03
39.18
49.24
58.55
56.74
55.97
56.12
53.02
55.64

JUL 12



Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c\,\frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = \left(1 - \frac{c}{100}\right) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide: $t = 3 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)

JUL 13

Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.

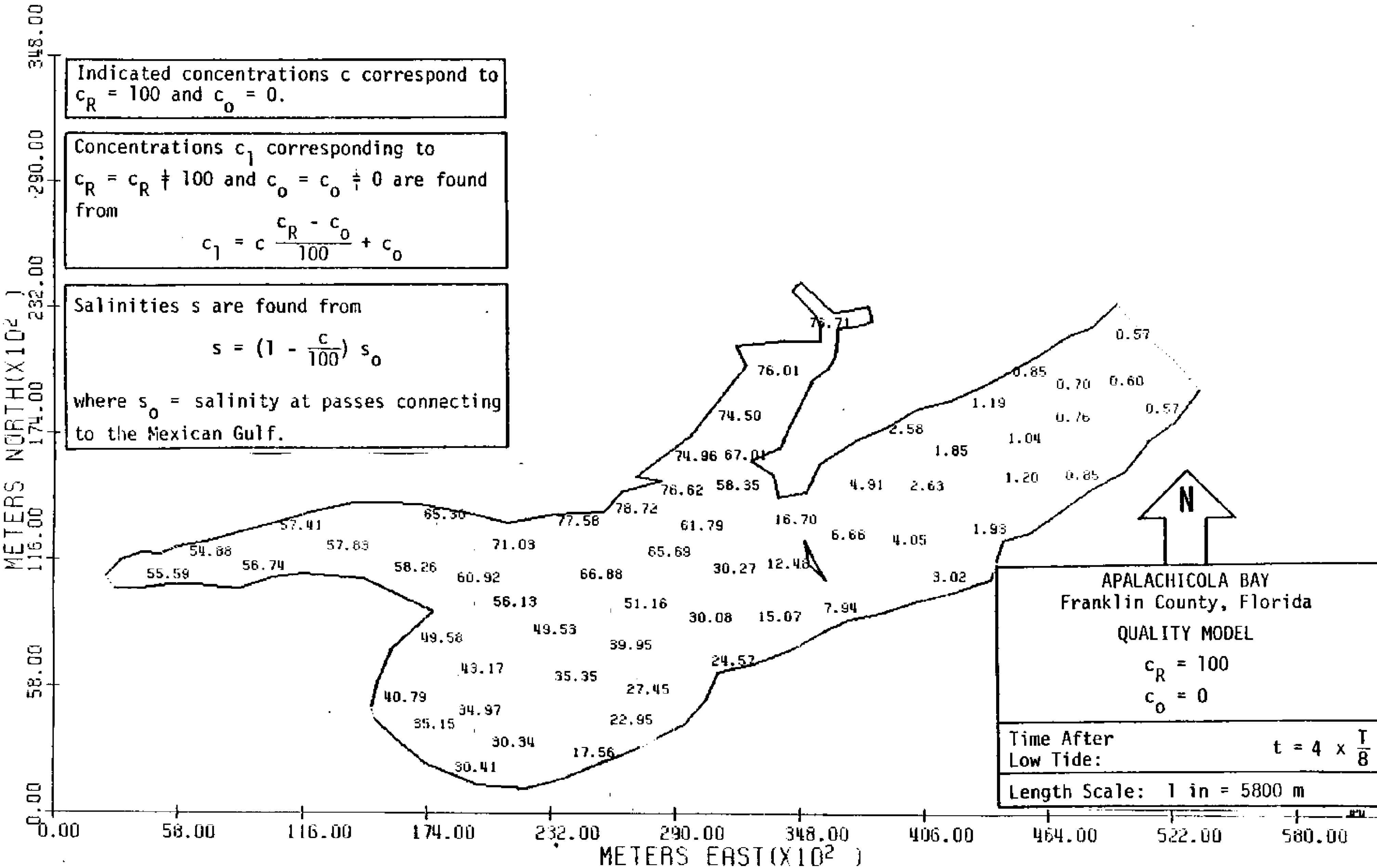
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from

$$c_1 = c\,\frac{c_R - c_o}{100} + c_o$$

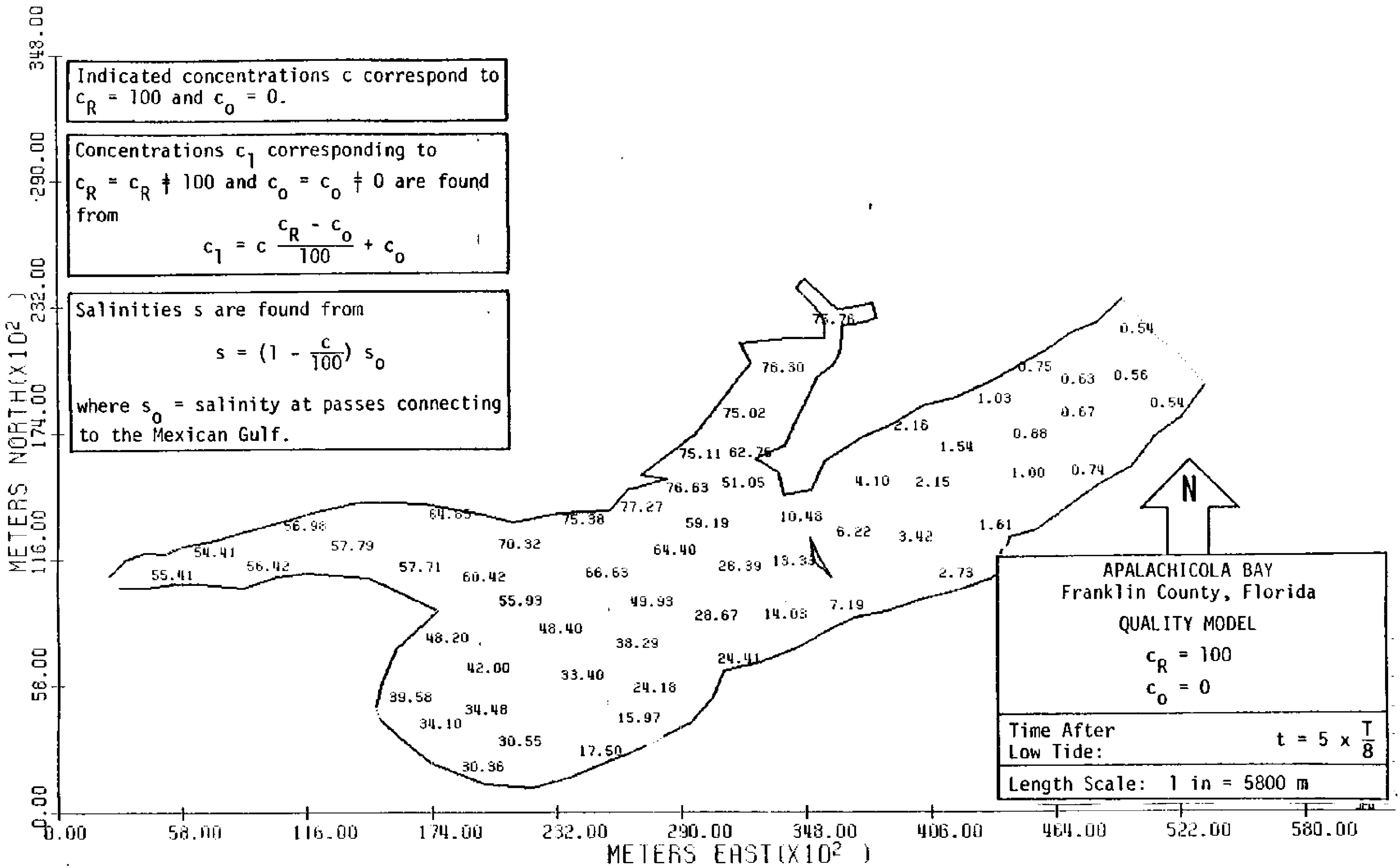
Salinities s are found from

$$s = \left(1 - \frac{c}{100}\right) s_o$$

where s_o = salinity at passes connecting to the Mexican Gulf.

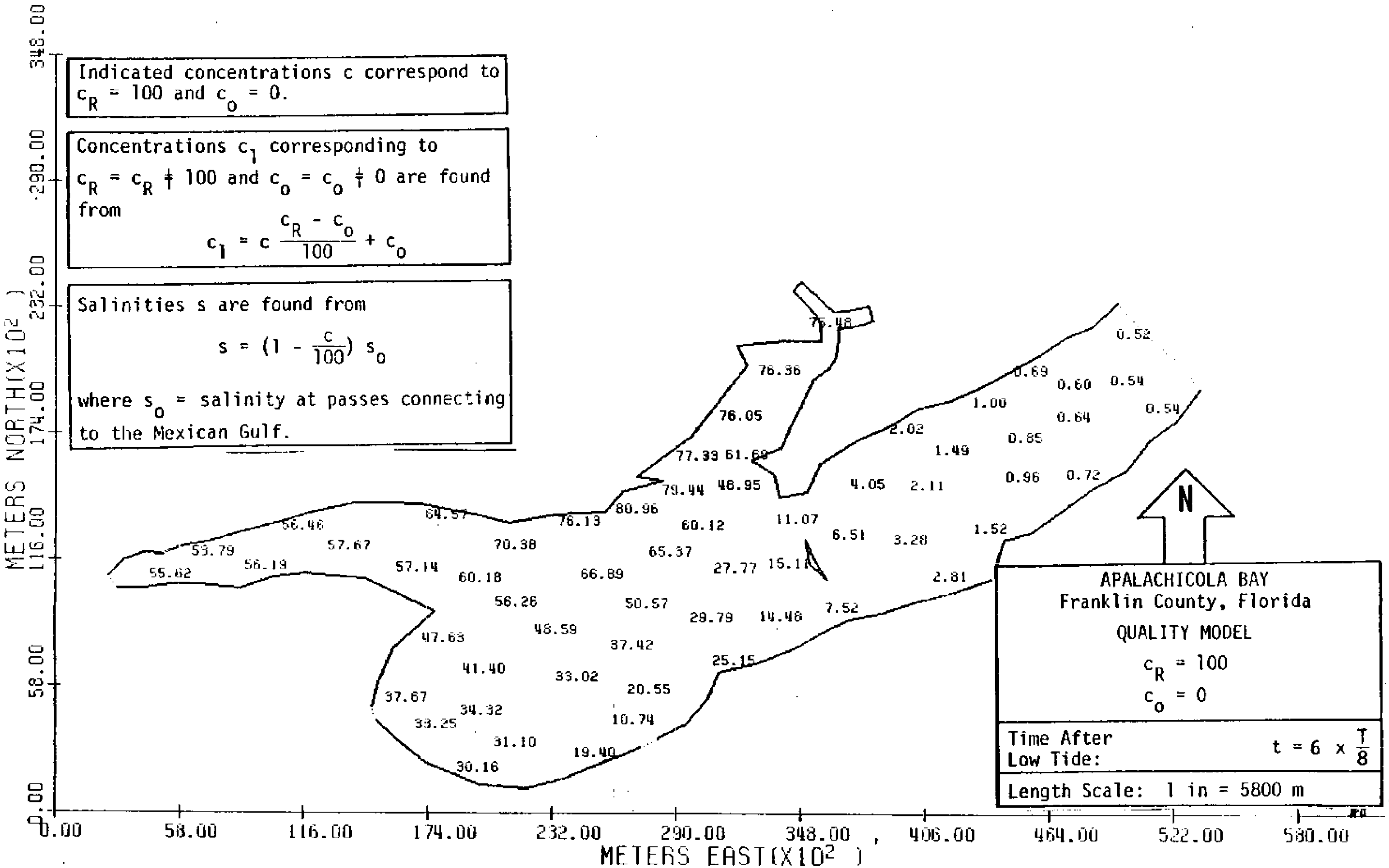


JUL 14

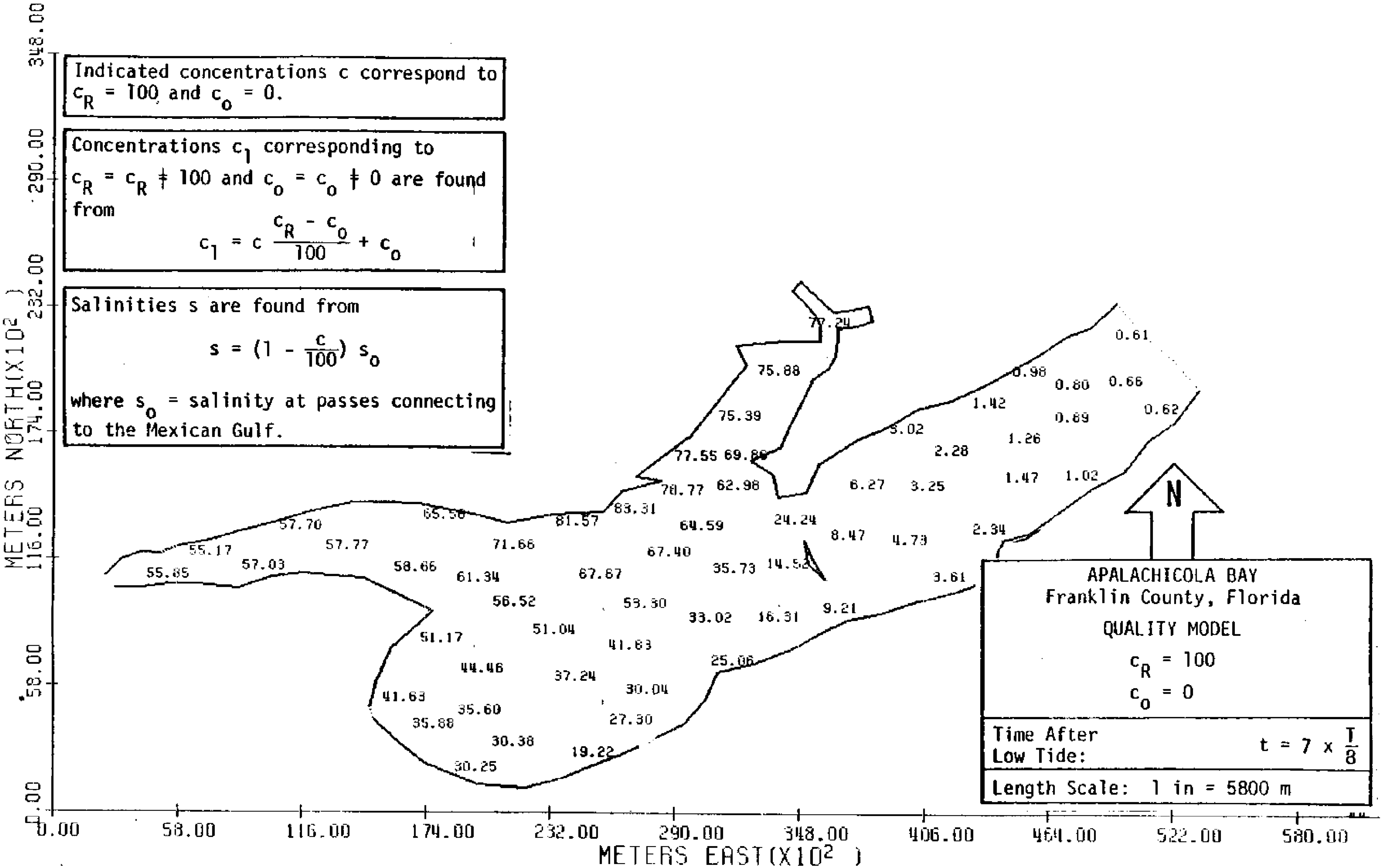


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c\,\frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = \left(1 - \frac{c}{100}\right) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide: $t = 5 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00

JUL 15


Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c \frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = (1 - \frac{c}{100}) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide: $t = 6 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS EAST(X10²)
METERS NORTH(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
55.62
53.79
56.19
56.46
57.67
57.14
64.57
60.18
70.38
56.26
47.63
41.40
37.67
33.25
34.32
31.10
30.16
48.59
33.02
19.40
10.74
20.55
37.42
50.57
66.89
76.13
80.96
79.44
77.33
61.69
76.05
76.36
75.48
48.95
60.12
65.37
27.77
29.79
14.46
15.11
11.07
25.15
7.52
6.51
4.05
2.11
3.28
2.81
1.52
1.49
2.02
1.00
0.85
0.96
0.72
0.64
0.60
0.69
0.54
0.54
0.52

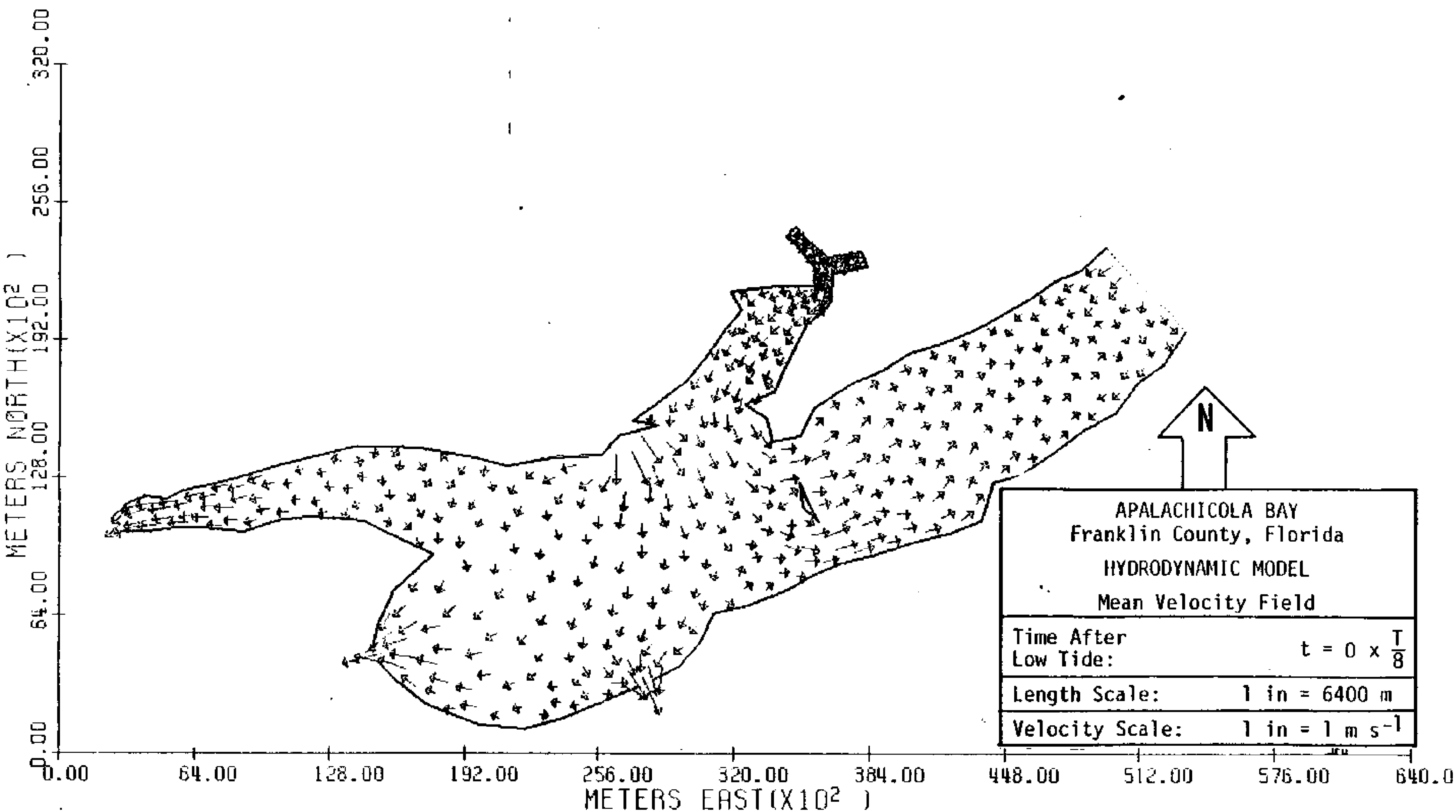
JUL 16


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 7 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
77.24
75.88
75.39
77.55
69.86
78.77
62.98
83.31
81.57
65.56
57.70
55.17
55.85
57.03
57.77
58.66
61.34
71.66
67.67
64.59
67.40
24.24
14.52
35.73
56.52
53.30
33.02
16.31
9.21
51.17
51.04
41.63
25.06
44.46
37.24
30.04
41.63
35.60
35.88
27.30
30.38
19.22
30.25
0.61
0.98
0.80
0.66
1.42
0.69
0.62
3.02
2.28
1.26
6.27
3.25
1.47
1.02
8.47
4.73
2.34
3.61

JUL 17

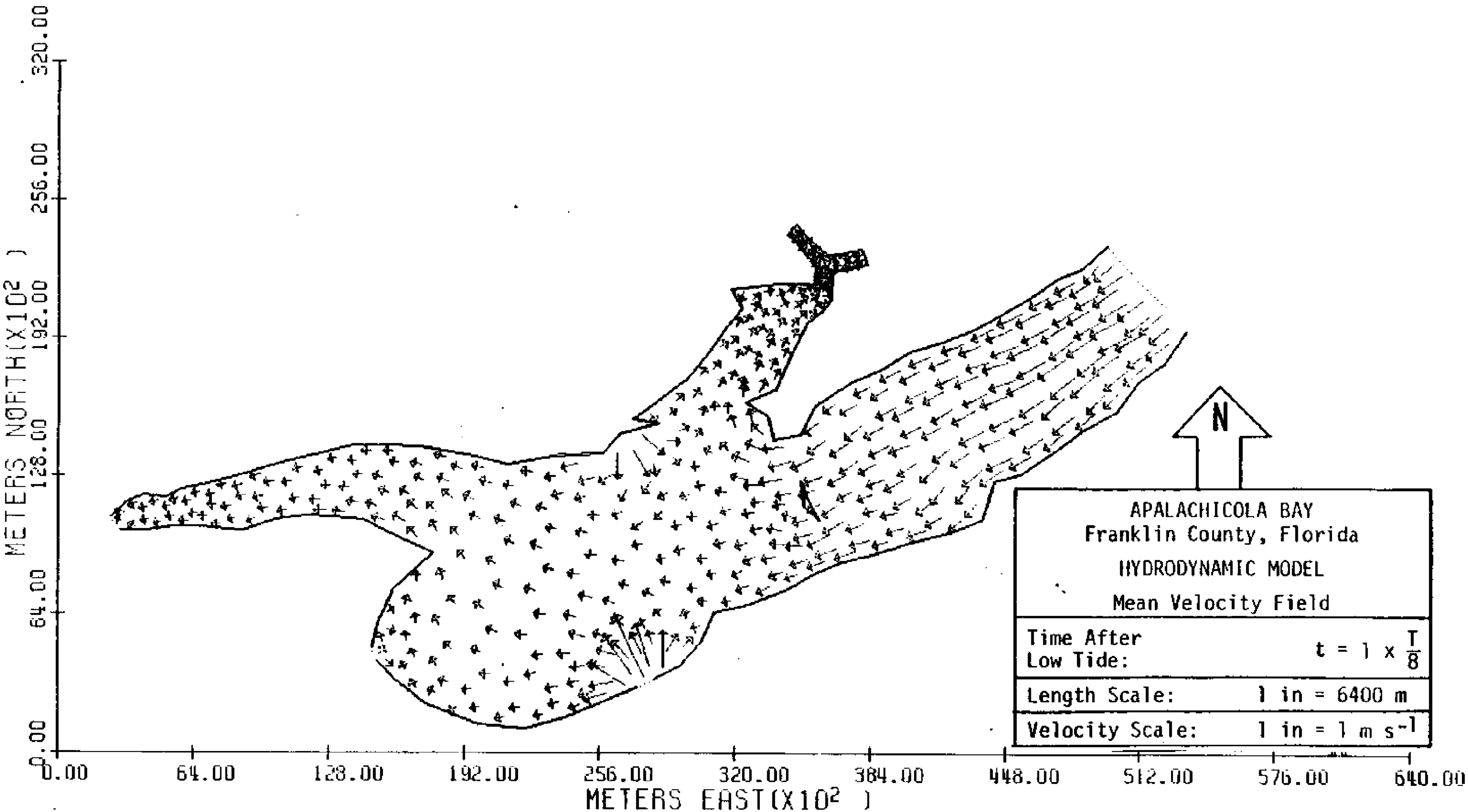
AUGUST

AUG 1 through AUG 8:	Vertically averaged velocities v_m given at time increments equal to one eighth of the tidal period beginning at low tide.
AUG 9:	Net values of vertically averaged velocities. Time averaged over one tidal cycle.
AUG 10 through AUG 17:	Vertically averaged pollutant concentration corresponding to river concentration $c_R = 100$ and concentration $c_o = 0$ at all inlets to bay. Concentrations given at time increments equal to one eighth of the tidal period beginning at low tide.

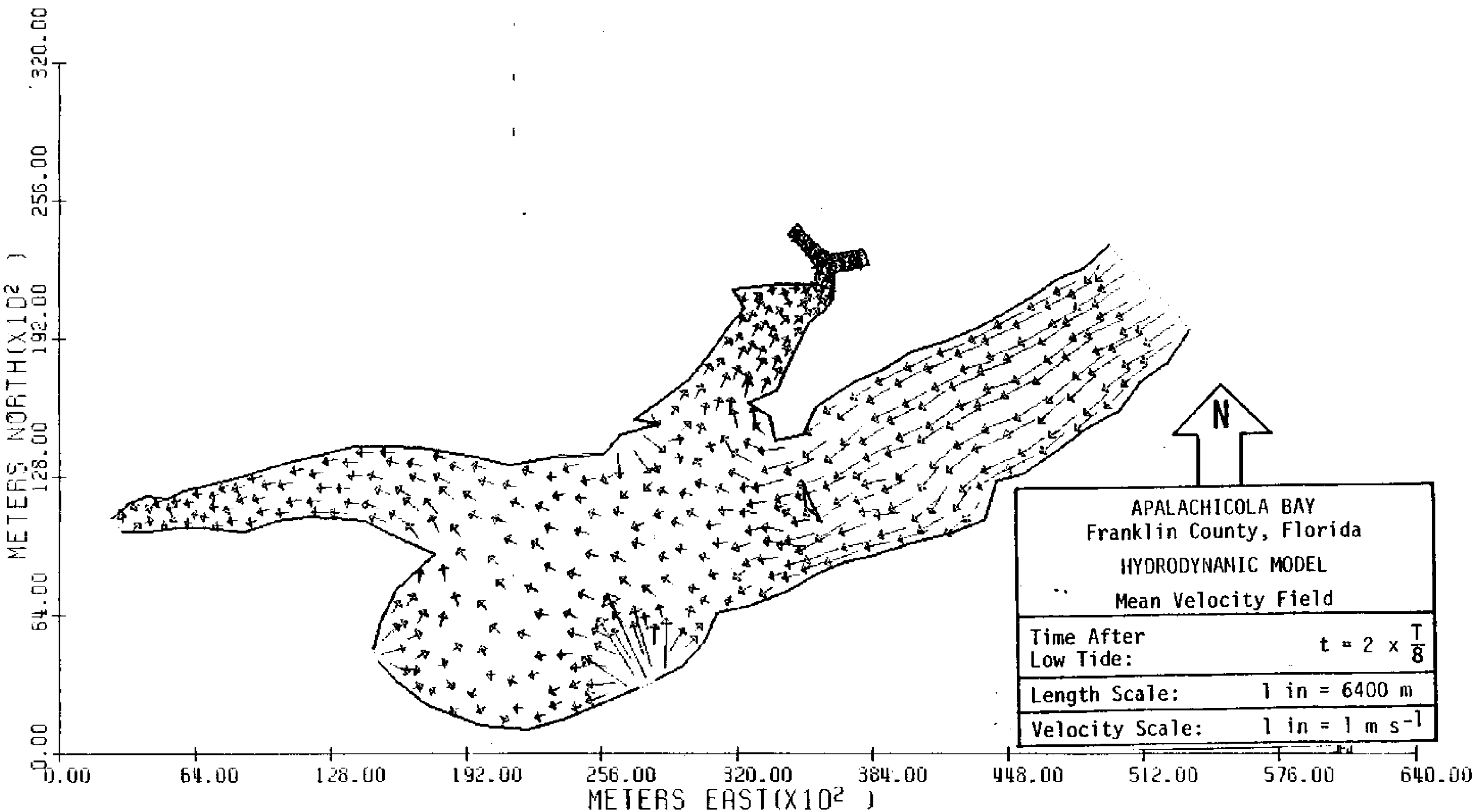


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 0 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

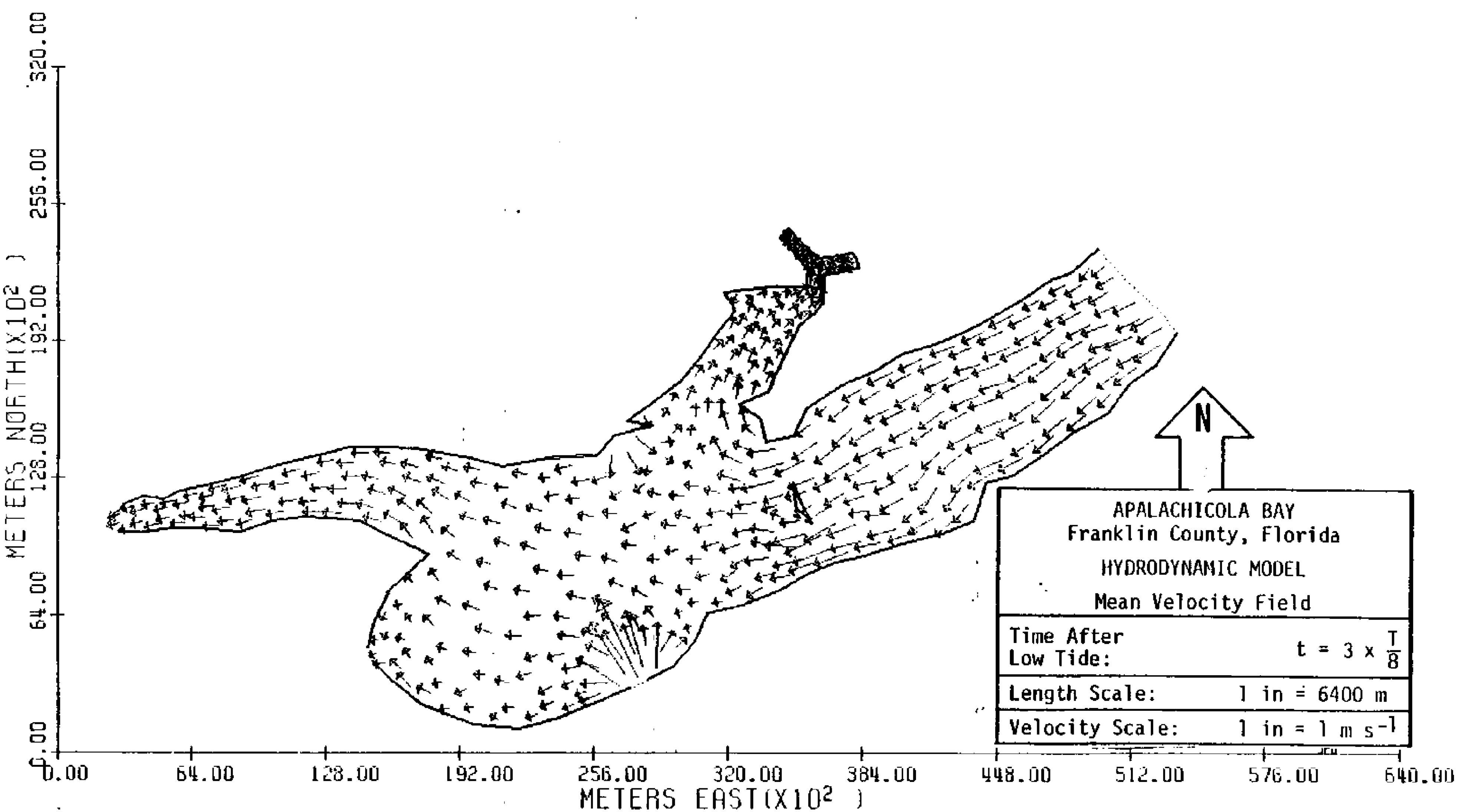
AUG 1


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide:
$t = 1 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

AUG 2

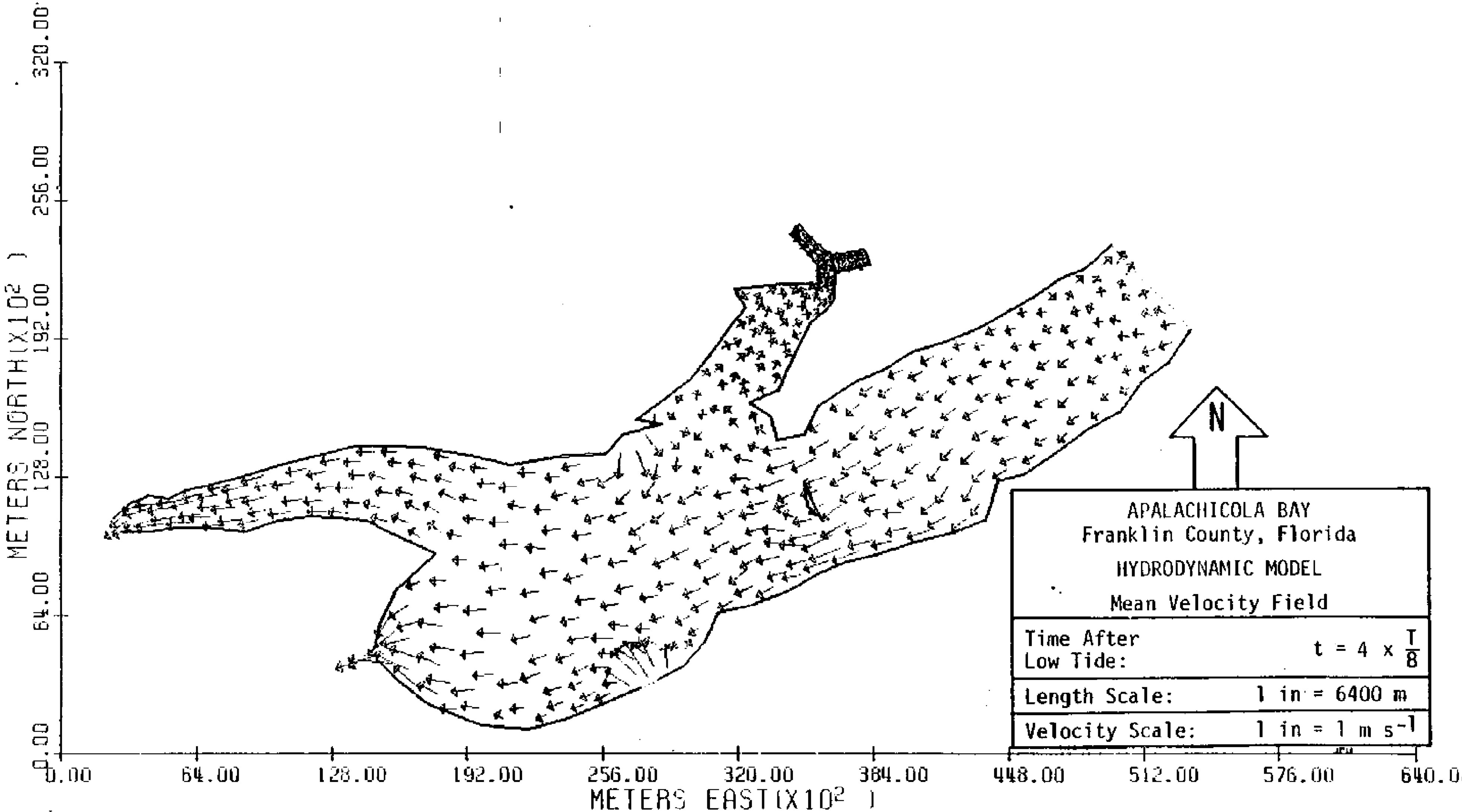

APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide:
t = 2 x T/8
Length Scale:
1 in = 6400 m
Velocity Scale:
1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

AUG 3

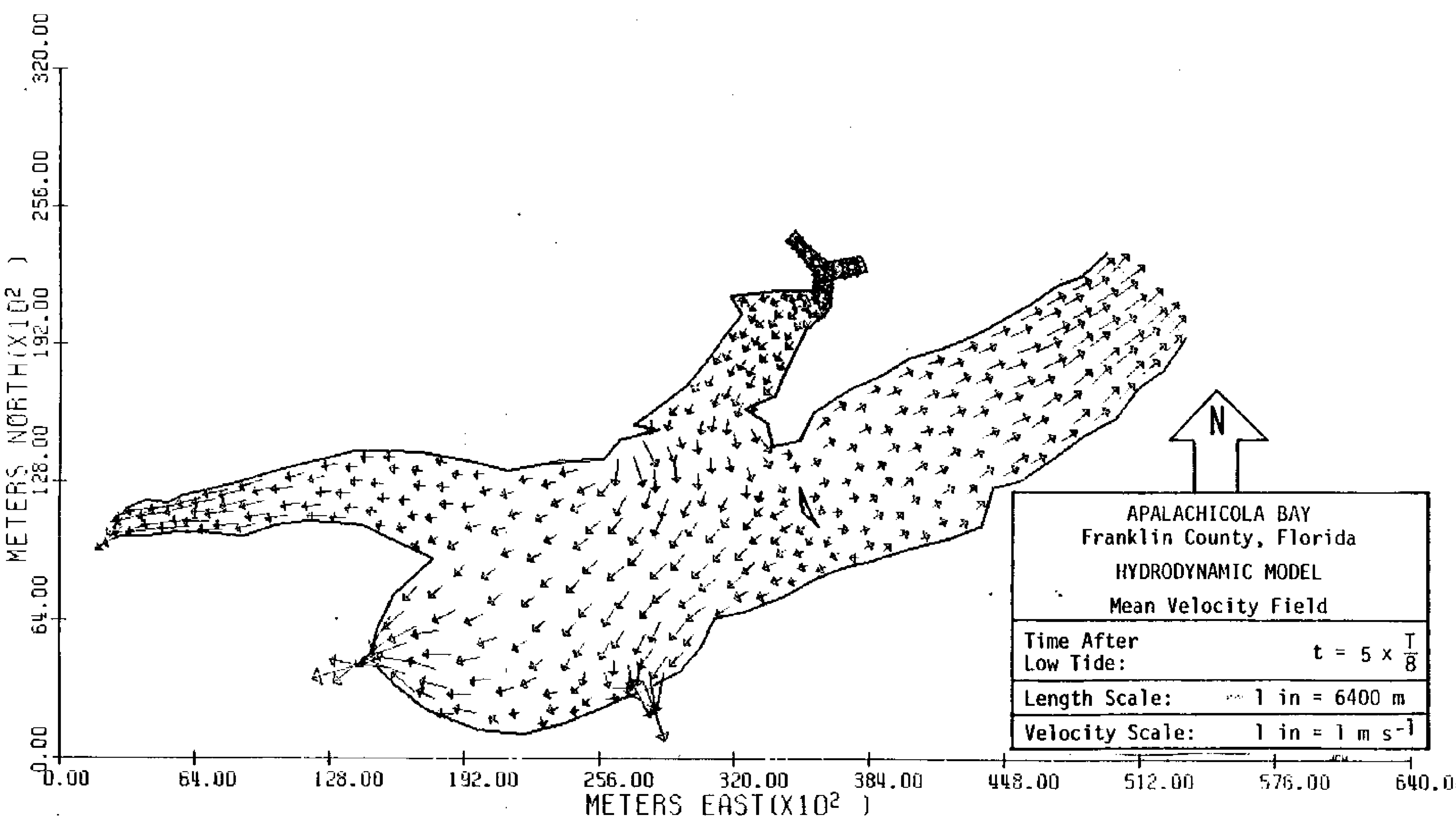


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 3 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH($X10^2$)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST($X10^2$)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

AUG 4

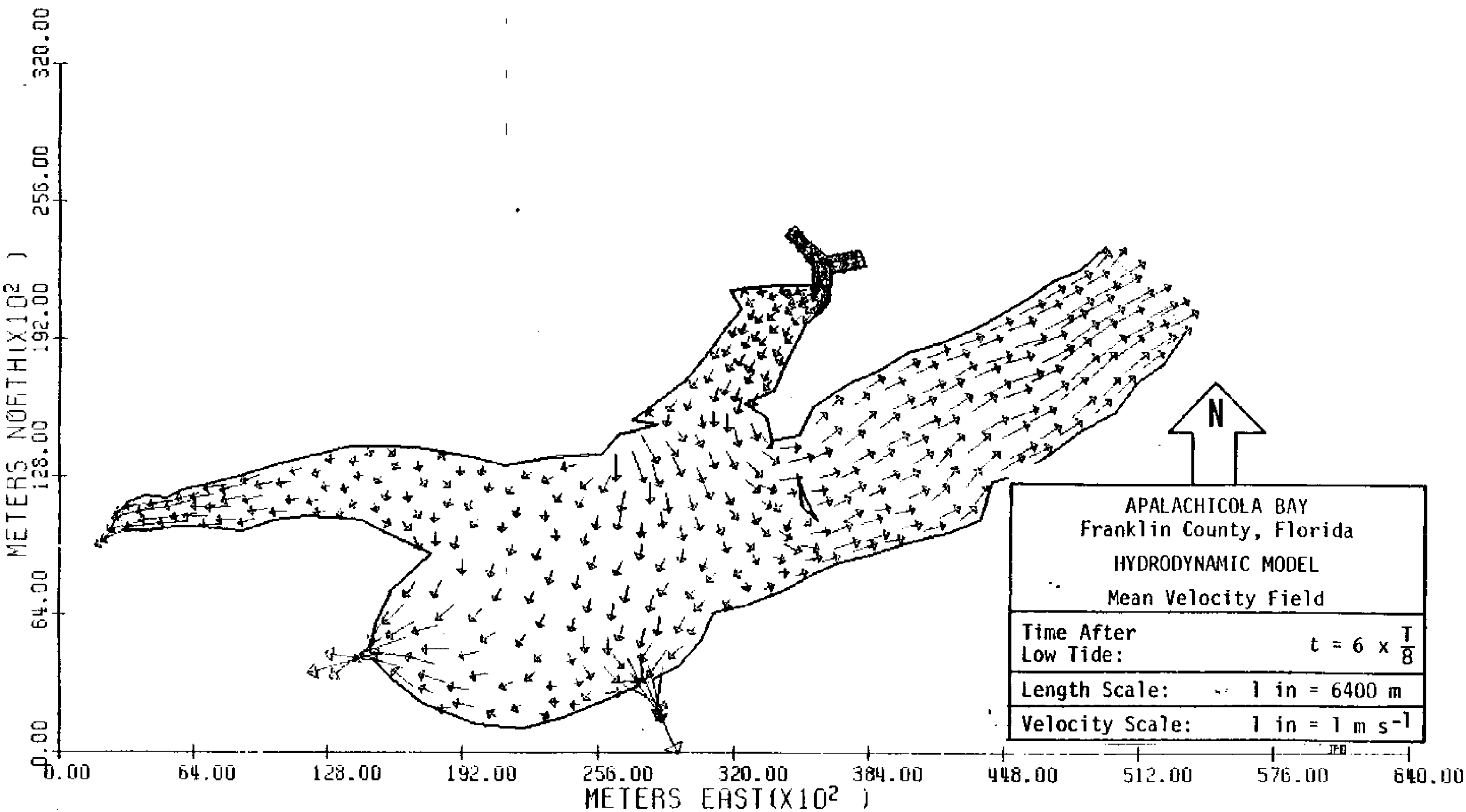

APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 4 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

AUG 5



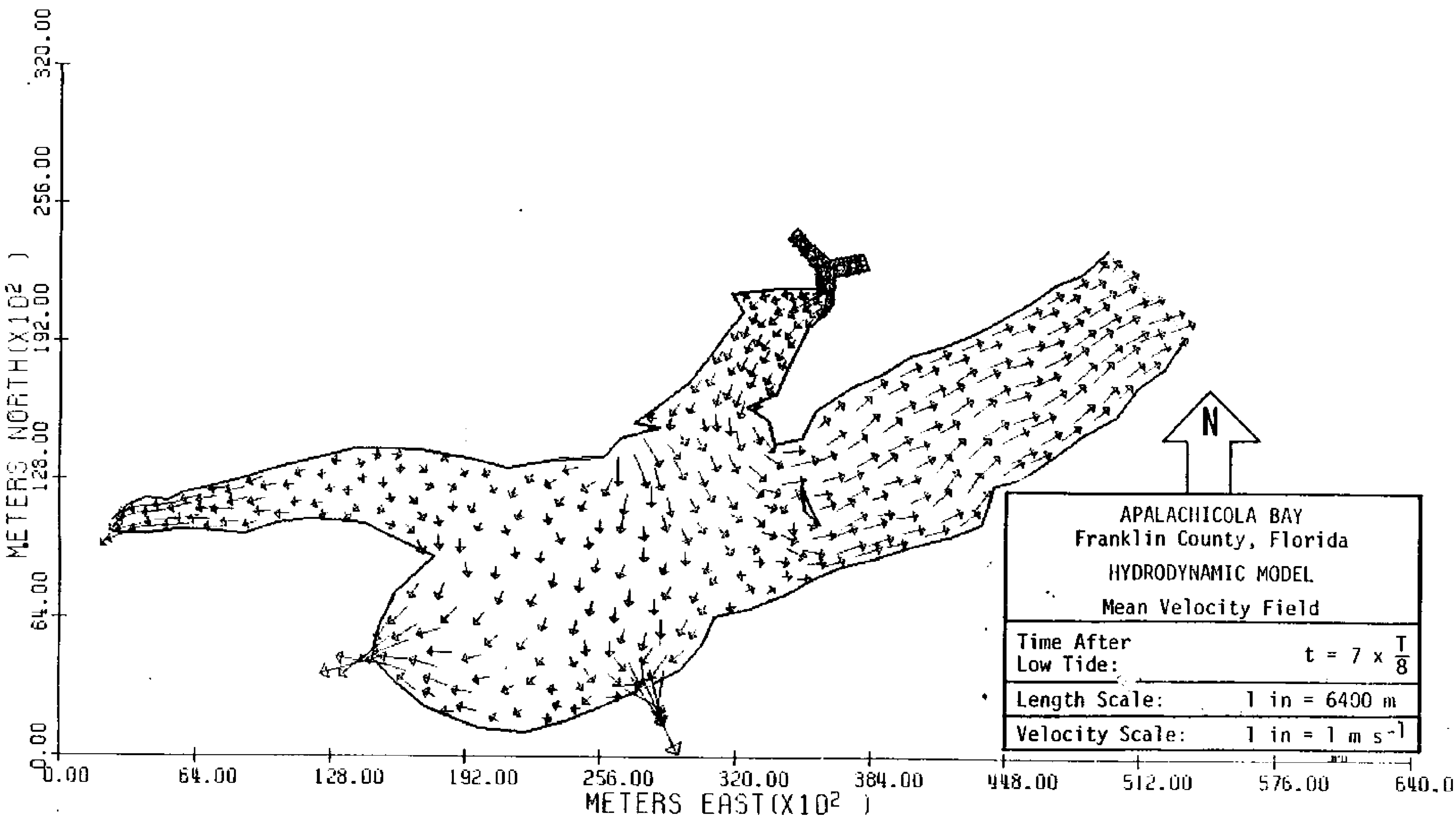
APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 5 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH($X10^2$)
METERS EAST($X10^2$)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

AUG 6



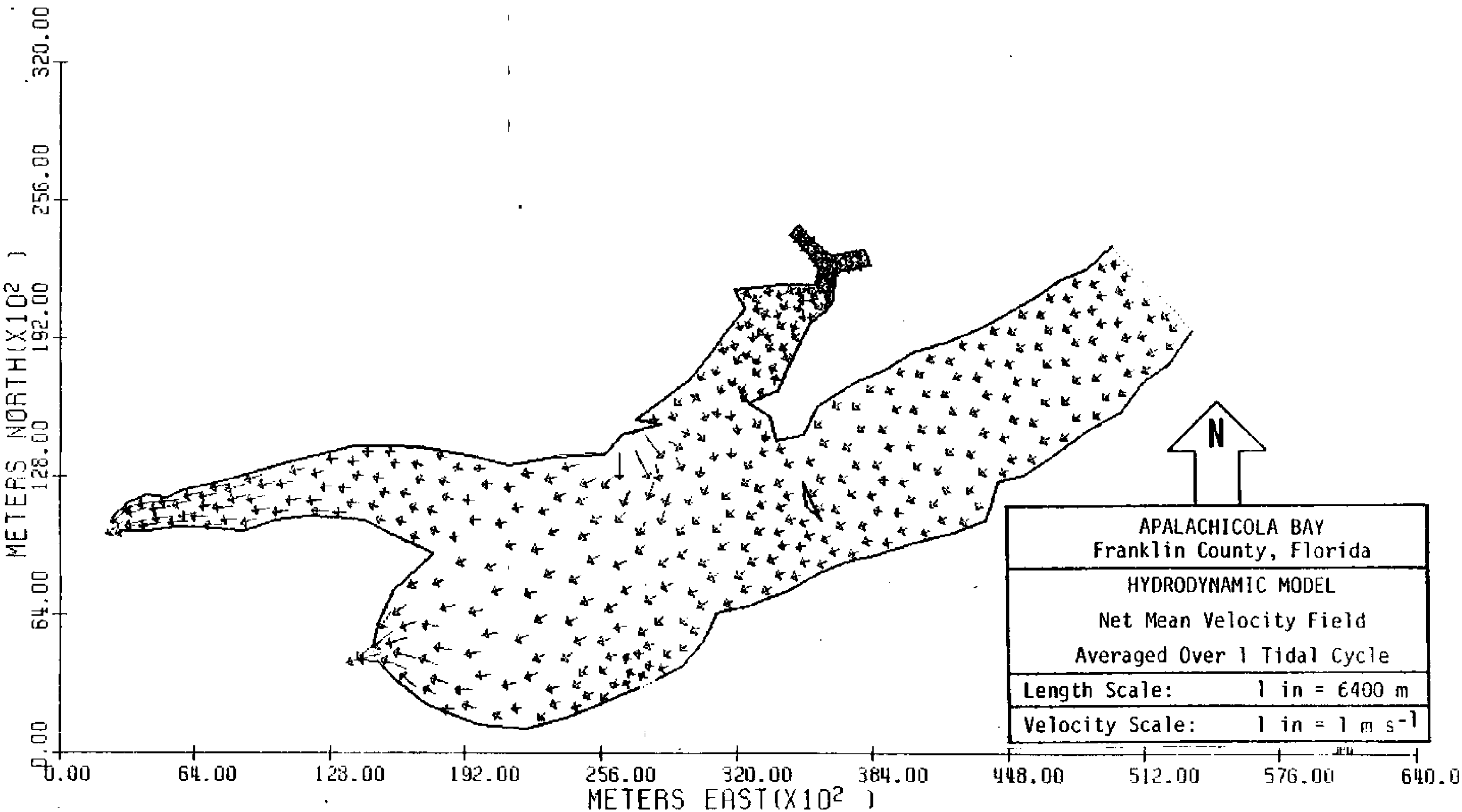
APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 6 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

AUG 7



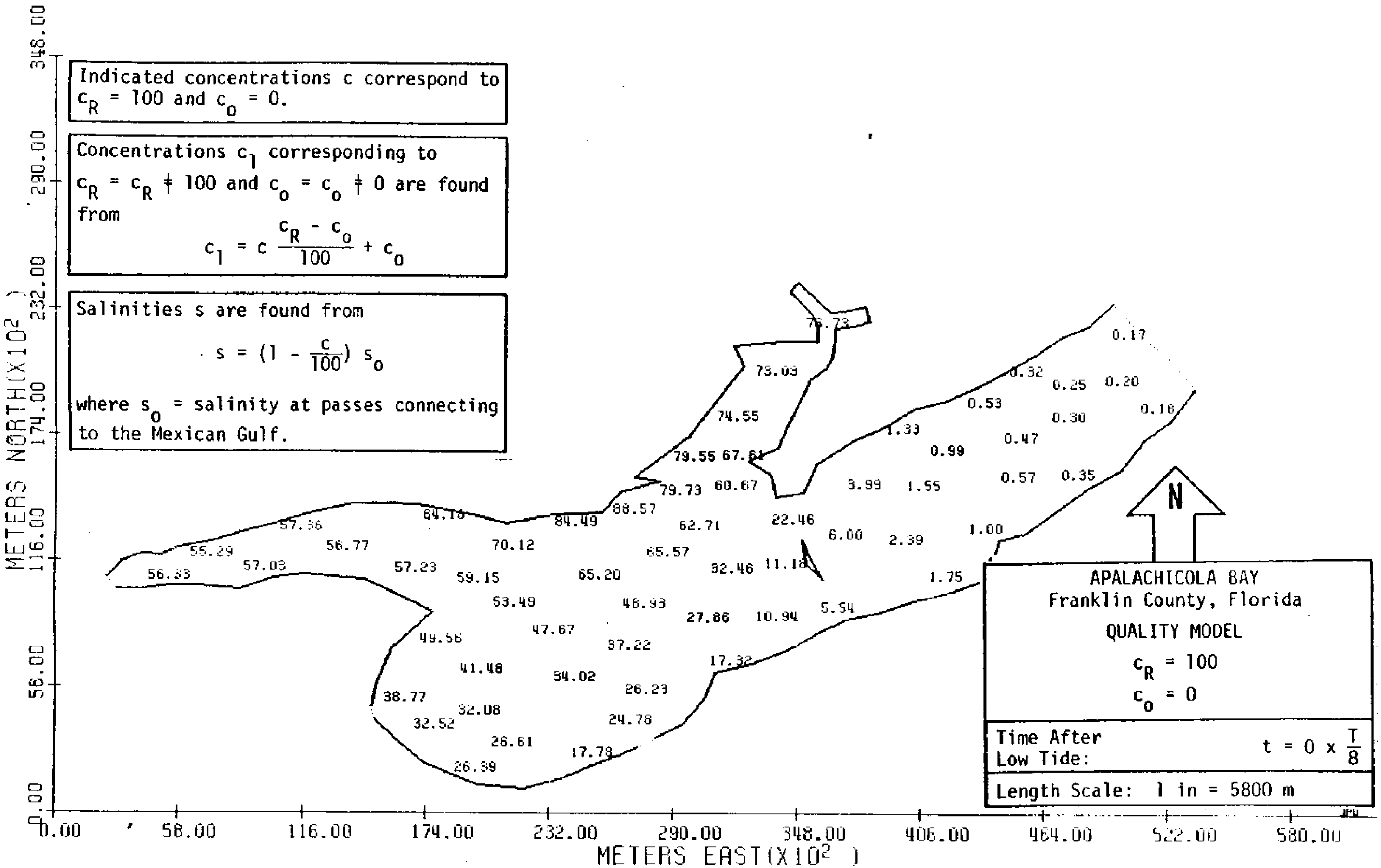
APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 7 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

AUG 8

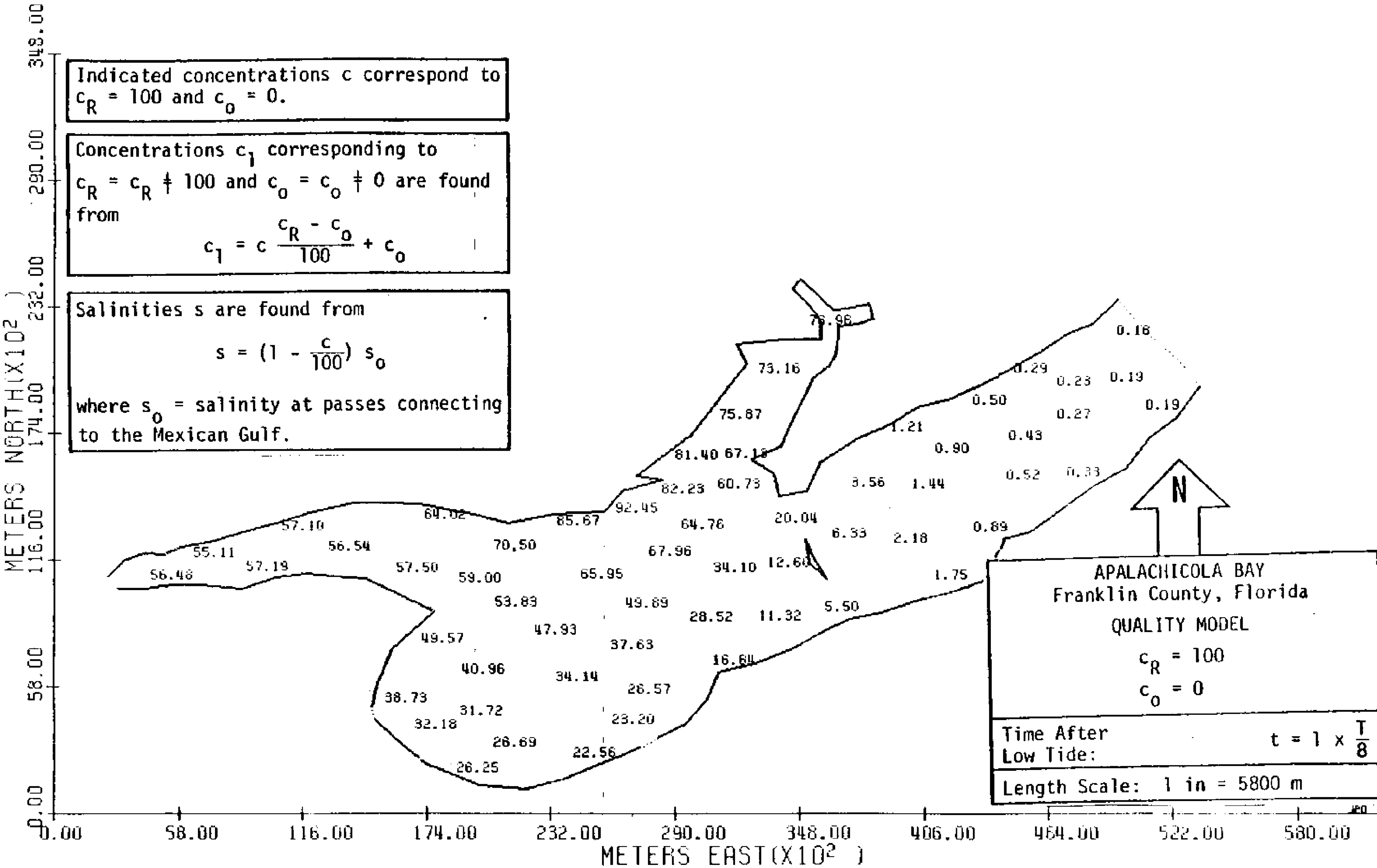


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Net Mean Velocity Field
Averaged Over 1 Tidal Cycle
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

AUG 9

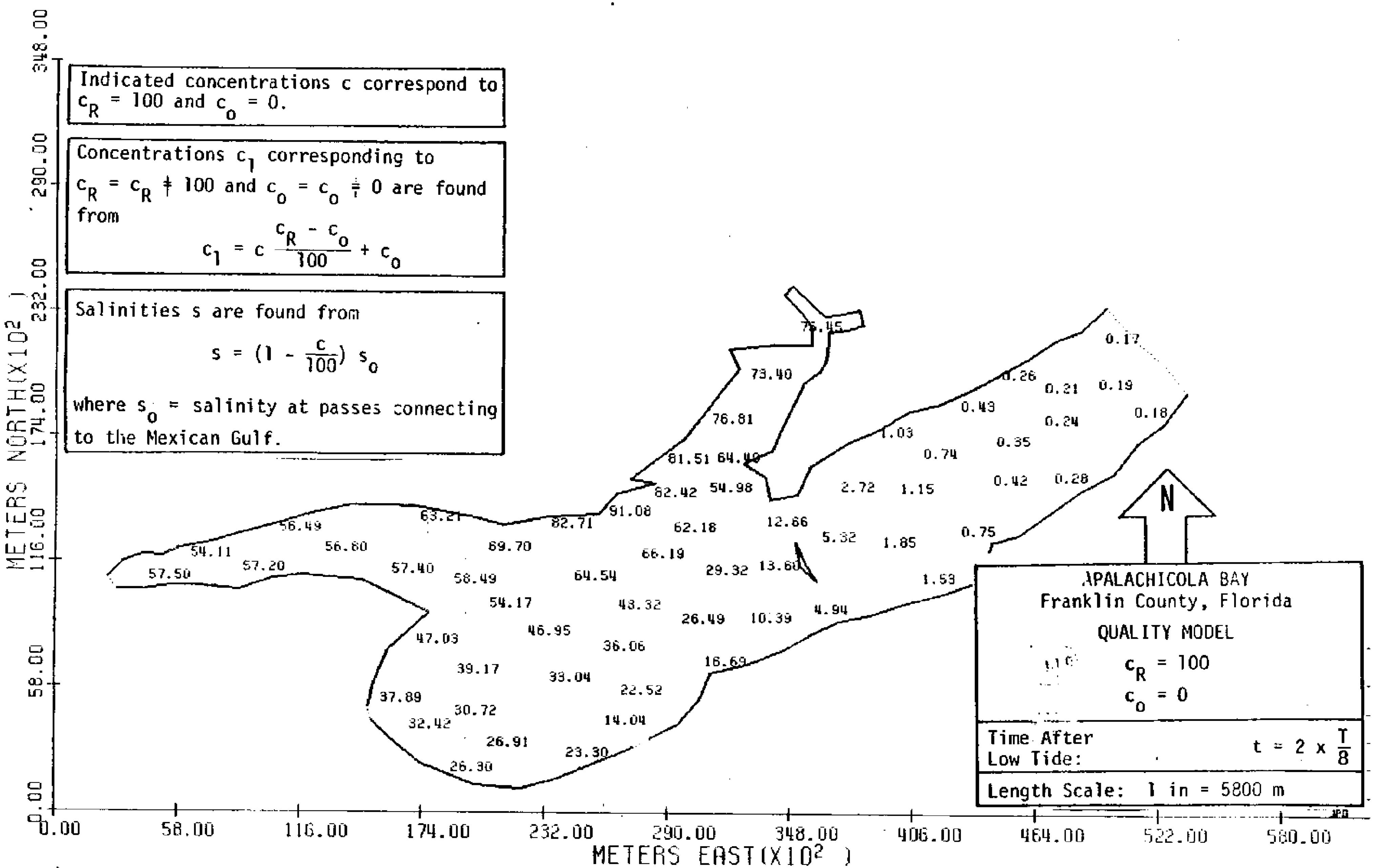

Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c \frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = (1 - \frac{c}{100})\, s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 0 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00

AUG 10

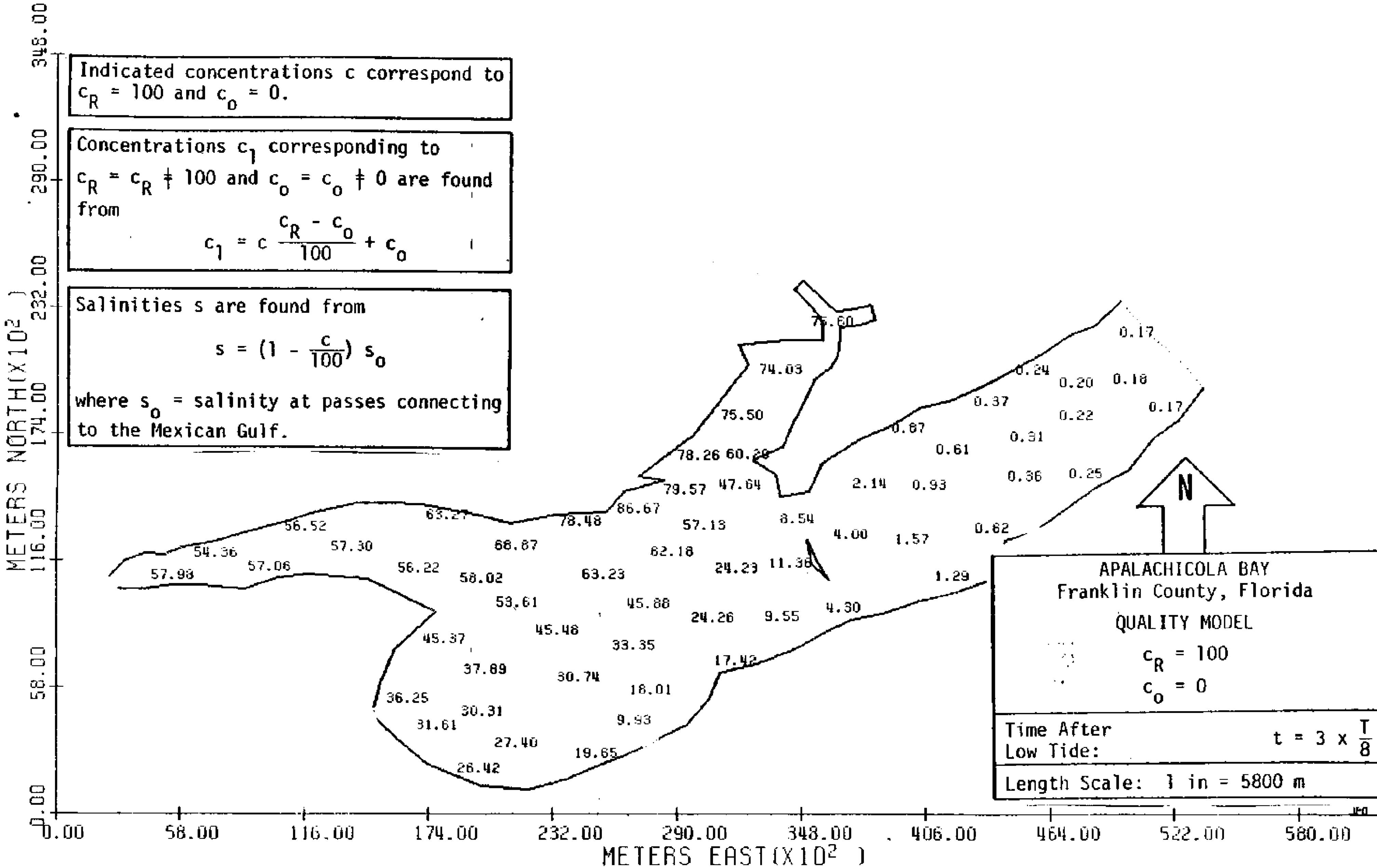


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 1 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
73.16
75.87
81.40
82.23
60.73
92.45
64.76
20.04
6.33
2.18
0.89
3.56
1.44
0.52
0.33
1.21
0.90
0.43
0.50
0.27
0.29
0.23
0.19
0.16
0.19
56.48
55.11
57.19
57.10
56.54
64.02
57.50
59.00
70.50
85.67
65.95
67.96
34.10
12.60
1.75
53.83
49.69
28.52
11.32
5.50
49.57
47.93
37.63
16.84
40.96
34.14
26.57
38.73
31.72
32.18
23.20
26.69
22.56
26.25

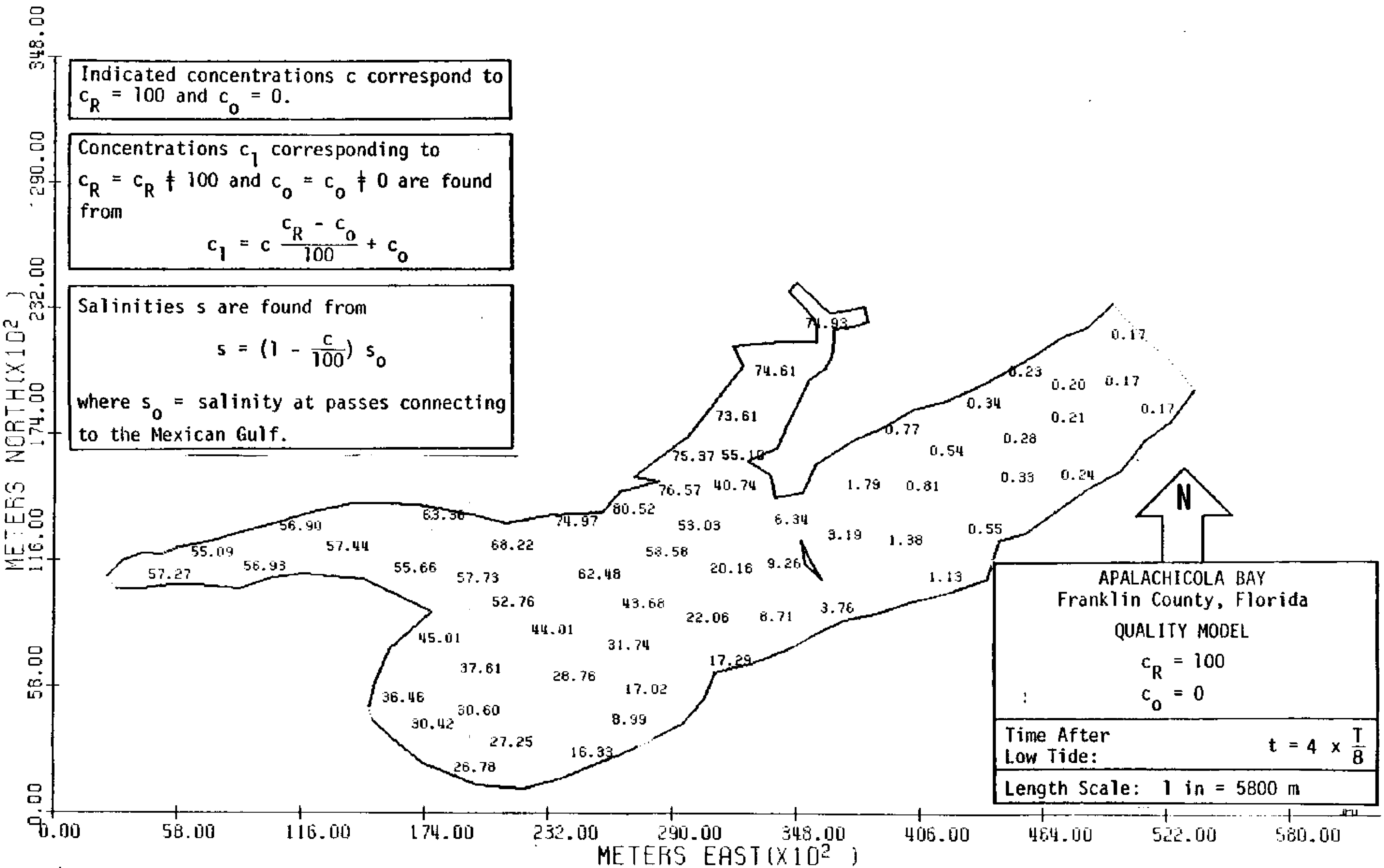
AUG 11


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c \frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = (1 - \frac{c}{100})\, s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 2 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
57.50
54.11
57.20
56.49
56.80
57.40
63.21
69.70
58.49
54.17
47.03
39.17
37.89
30.72
32.42
26.30
26.91
46.95
33.04
23.30
14.04
22.52
36.06
43.32
64.54
82.71
91.08
66.19
62.18
62.42
81.51
64.40
54.98
76.81
73.40
75.45
29.32
26.49
10.39
16.69
13.60
12.66
4.94
5.32
2.72
1.85
1.15
1.03
0.74
1.53
0.75
0.43
0.35
0.42
0.26
0.21
0.24
0.28
0.17
0.19
0.18

AUG 12

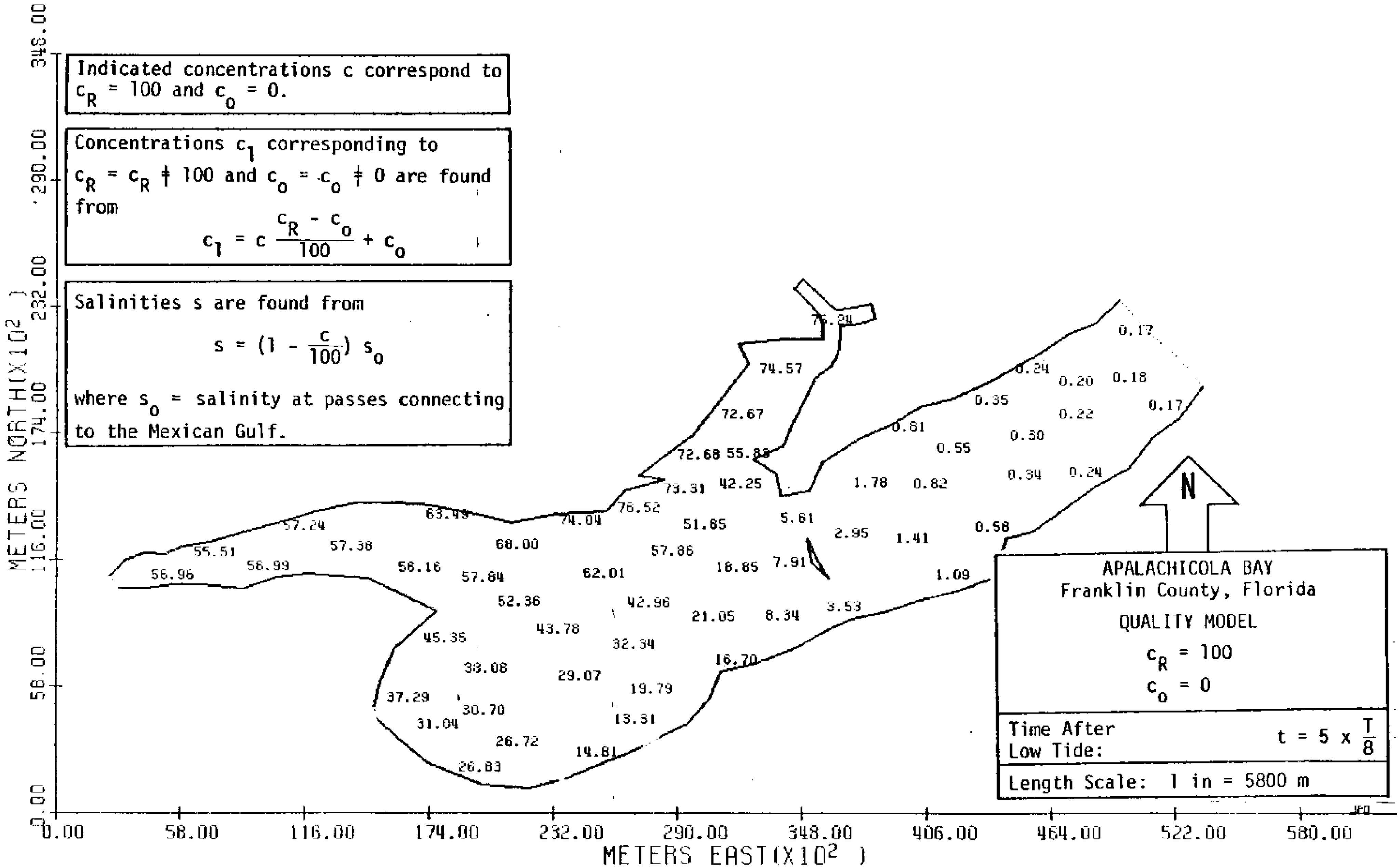

Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 3 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
57.98
54.36
57.06
56.52
57.30
63.27
56.22
58.02
68.87
78.48
53.61
63.23
45.37
37.89
45.48
36.25
31.61
30.31
27.40
26.42
30.74
19.65
33.35
16.01
9.93
86.67
79.57
78.26
60.28
75.50
74.03
75.60
47.64
57.13
62.18
45.88
24.26
24.23
8.54
11.38
9.55
17.42
4.30
4.00
2.14
0.87
1.57
0.93
0.61
1.29
0.62
0.37
0.24
0.36
0.31
0.25
0.22
0.20
0.18
0.17
0.17

AUG 13

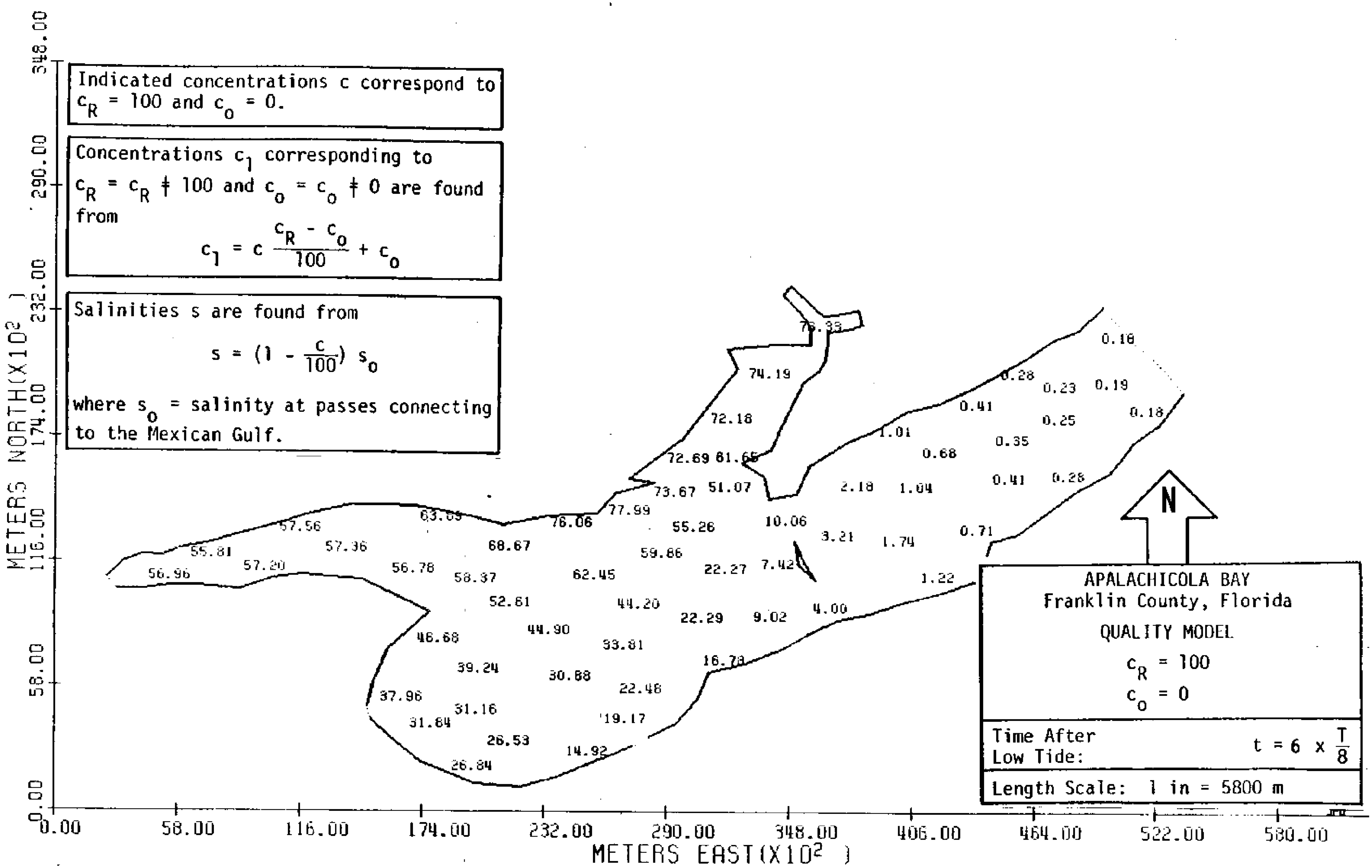


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c\,\frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = \left(1 - \frac{c}{100}\right) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 4 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
57.27
55.09
56.93
56.90
57.44
55.66
63.30
57.73
68.22
52.76
45.01
37.61
36.46
30.60
30.42
27.25
26.78
44.01
28.76
74.97
62.48
80.52
76.57
75.37
73.61
74.61
74.93
55.10
40.74
53.03
58.58
43.68
31.74
17.02
8.99
16.33
22.06
20.16
17.29
6.34
9.26
8.71
3.76
3.19
1.79
1.38
1.13
0.81
0.77
0.54
0.55
0.34
0.28
0.33
0.23
0.20
0.21
0.24
0.17
0.17
0.17

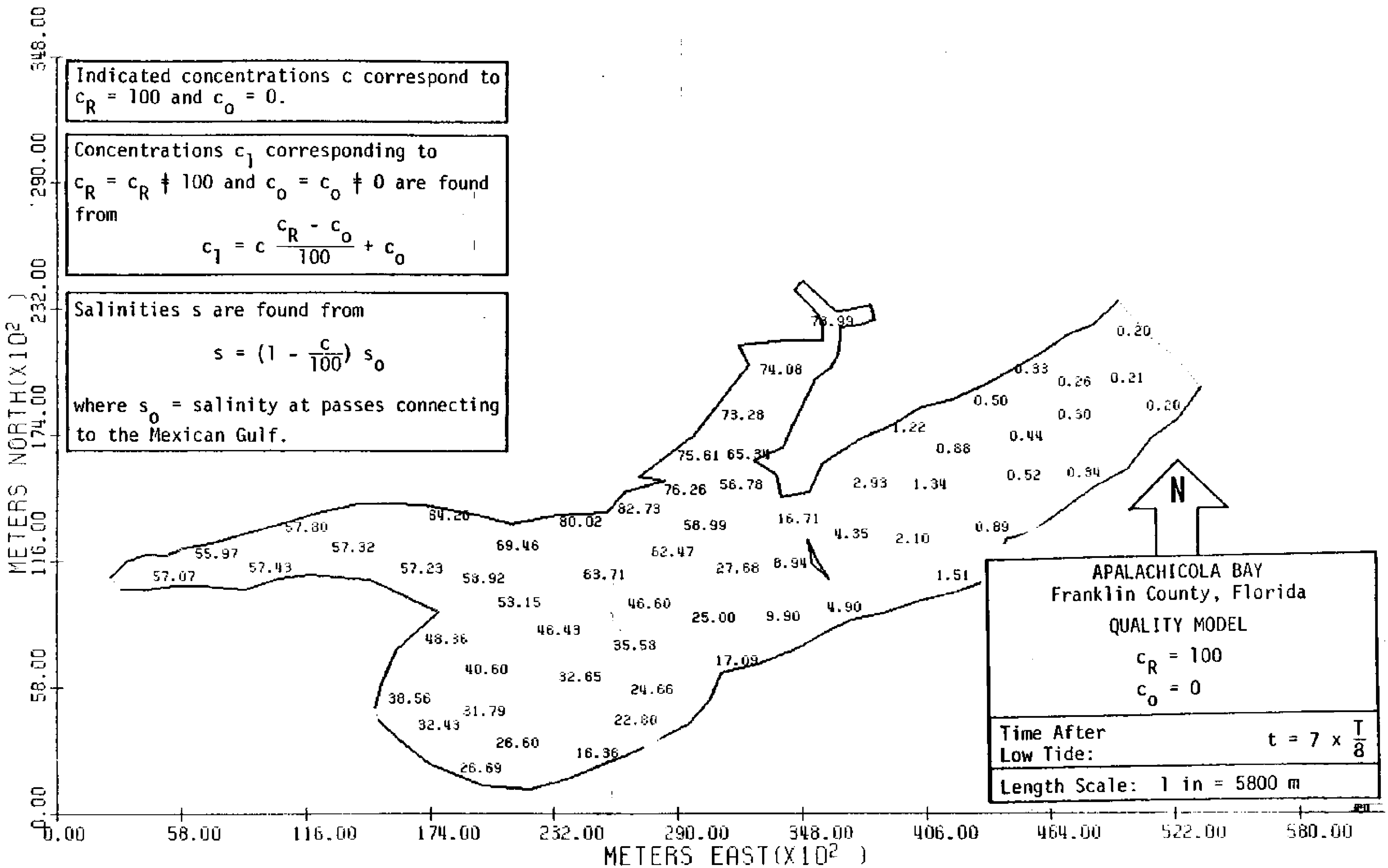
AUG 14


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100})\, s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
N
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 5 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
56.96
55.51
56.99
57.24
57.38
56.16
63.49
68.00
57.84
52.36
45.35
43.78
38.08
37.29
31.04
30.70
26.72
26.83
29.07
14.81
13.31
19.79
32.34
42.96
62.01
74.04
76.52
73.31
72.68
72.67
74.57
55.83
42.25
51.85
57.86
18.85
21.05
8.34
16.70
5.61
7.91
2.95
3.53
1.78
1.41
0.82
0.55
0.61
0.35
0.24
0.30
0.34
0.58
1.09
0.20
0.22
0.24
0.18
0.17
0.17

AUG 15


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 6 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)

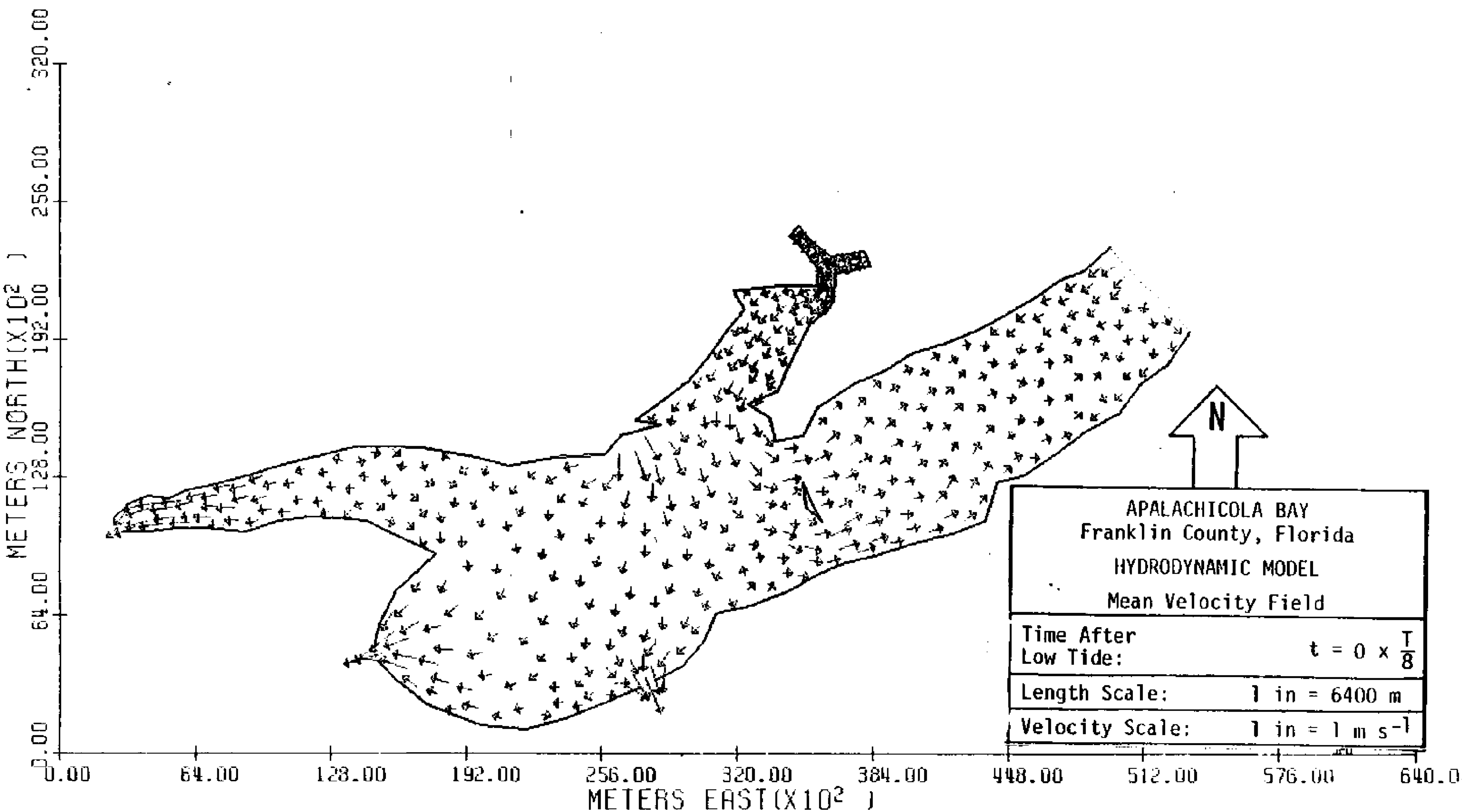
AUG 16


Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide: $t = 7 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
57.07
55.97
57.80
57.43
57.32
57.23
84.20
58.92
69.46
53.15
48.36
40.60
38.56
32.43
31.79
26.69
26.60
46.43
32.65
80.02
63.71
16.36
22.80
24.66
35.58
46.60
82.73
62.47
58.99
76.26
75.61
65.34
56.78
73.28
74.08
78.99
25.00
17.09
27.68
9.90
8.94
16.71
4.90
4.35
2.93
2.10
1.34
1.22
1.51
0.88
0.89
0.52
0.44
0.50
0.34
0.30
0.26
0.33
0.21
0.20
0.20

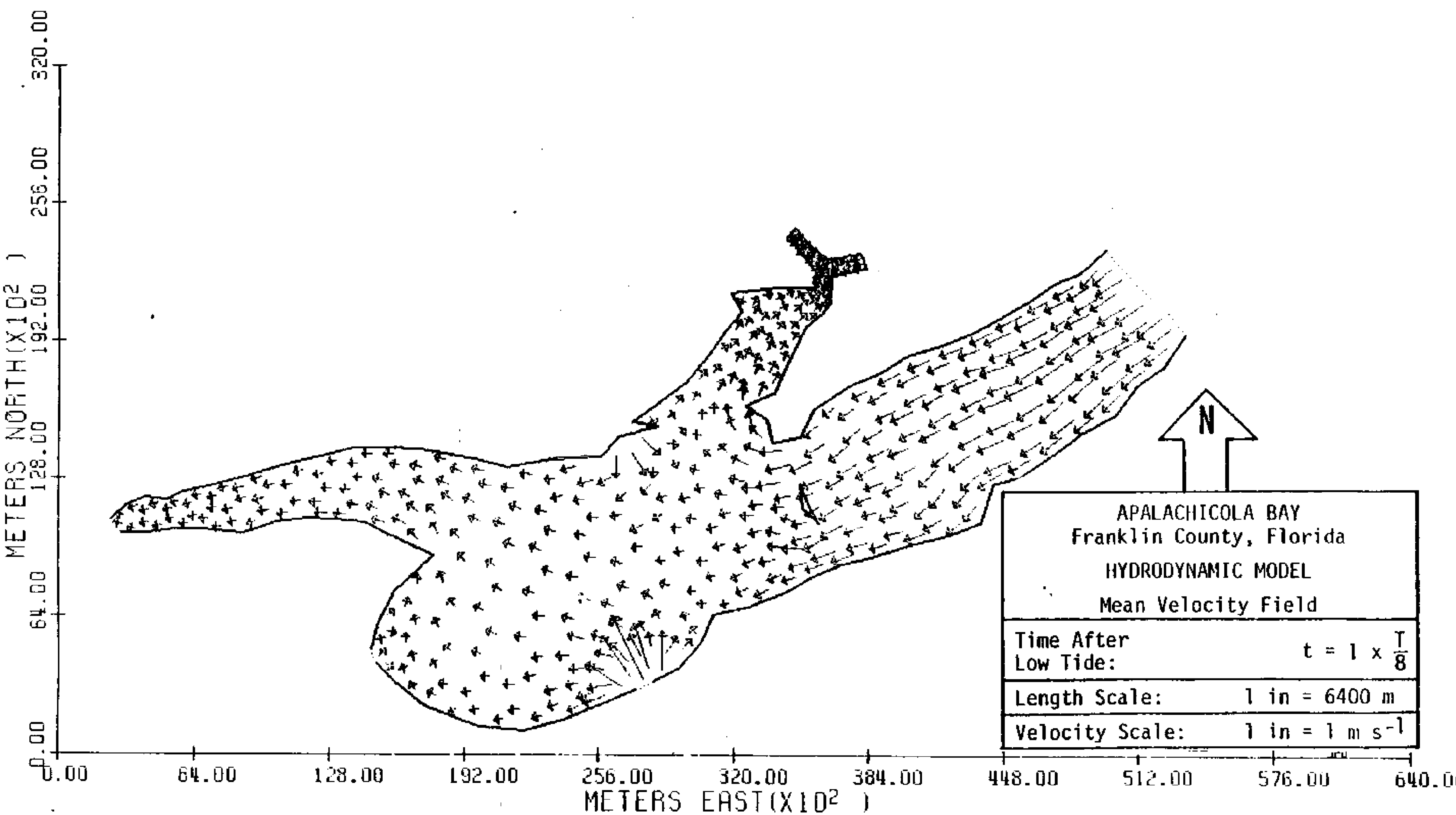
AUG 17

SEPTEMBER

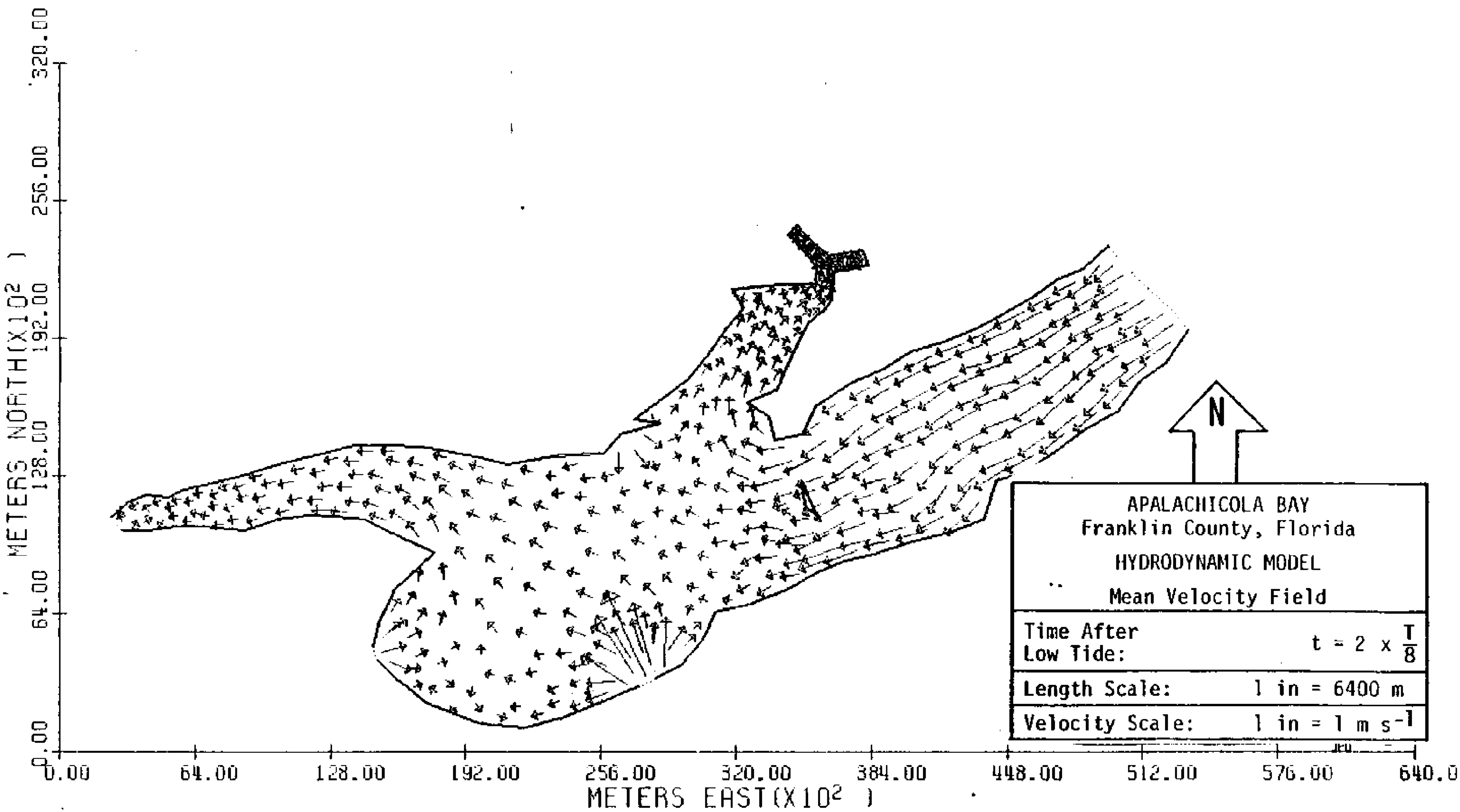
SEP 1 through SEP 8:	Vertically averaged velocities v_m given at time increments equal to one eighth of the tidal period beginning at low tide.
SEP 9:	Net values of vertically averaged velocities. Time averaged over one tidal cycle.
SEP 10 through SEP 17:	Vertically averaged pollutant concentration corresponding to river concentration c_R = 100 and concentration c_o = 0 at all inlets to bay. Concentrations given at time increments equal to one eighth of the tidal period beginning at low tide.


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 0 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH($X10^2$)
METERS EAST($X10^2$)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

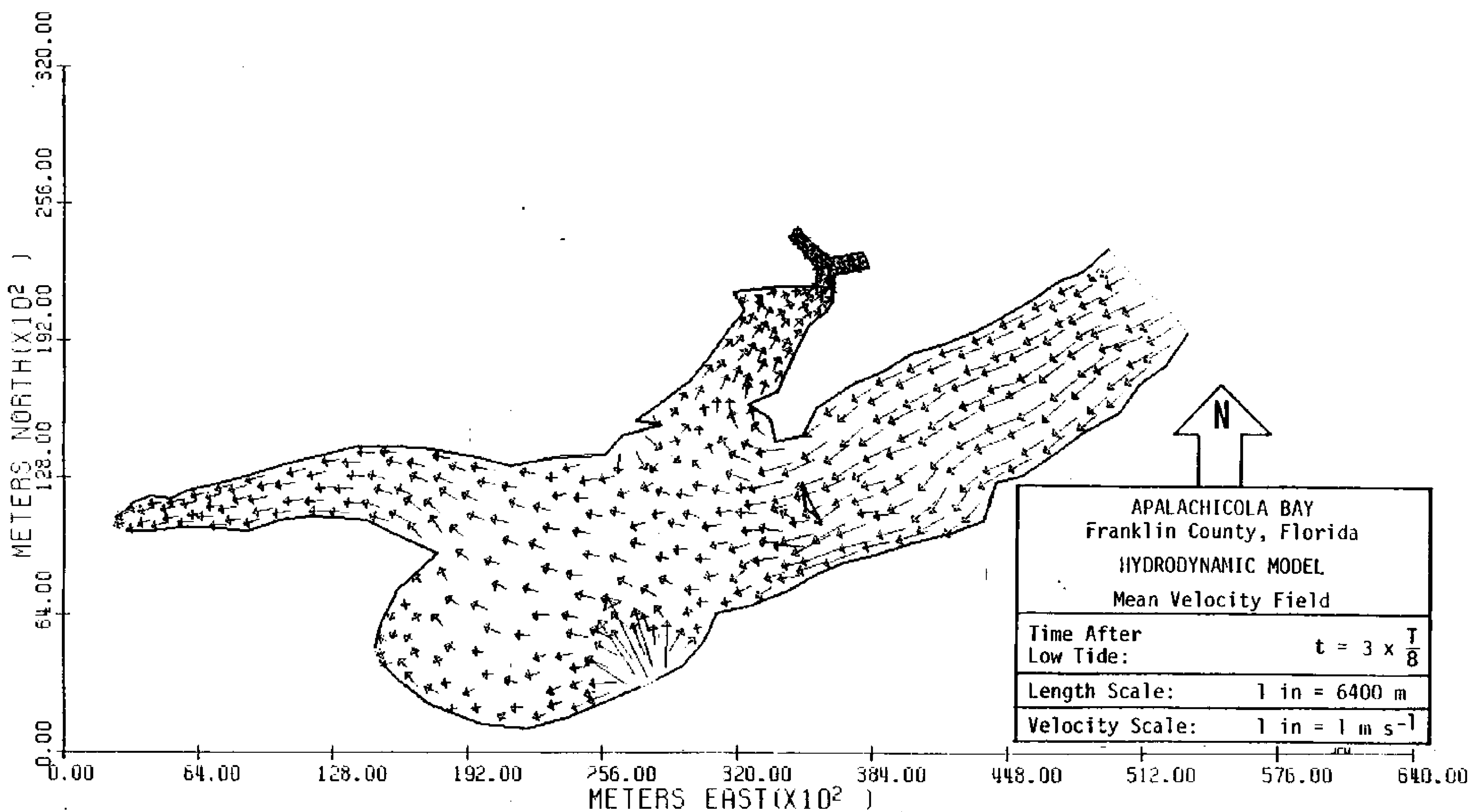
SEP 1


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 1 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH($X10^2$)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST($X10^2$)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

SEP 2

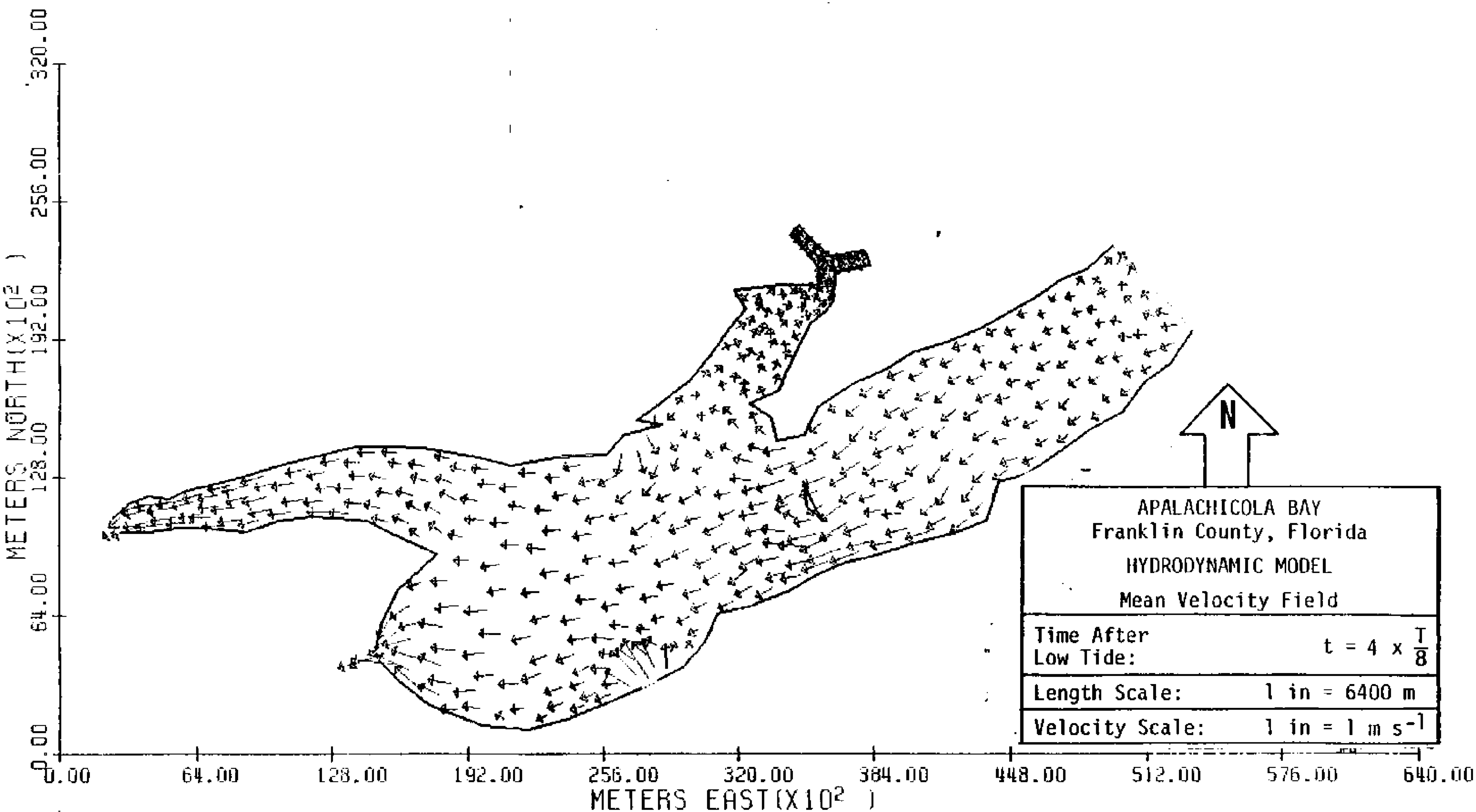

APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 2 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

SEP 3

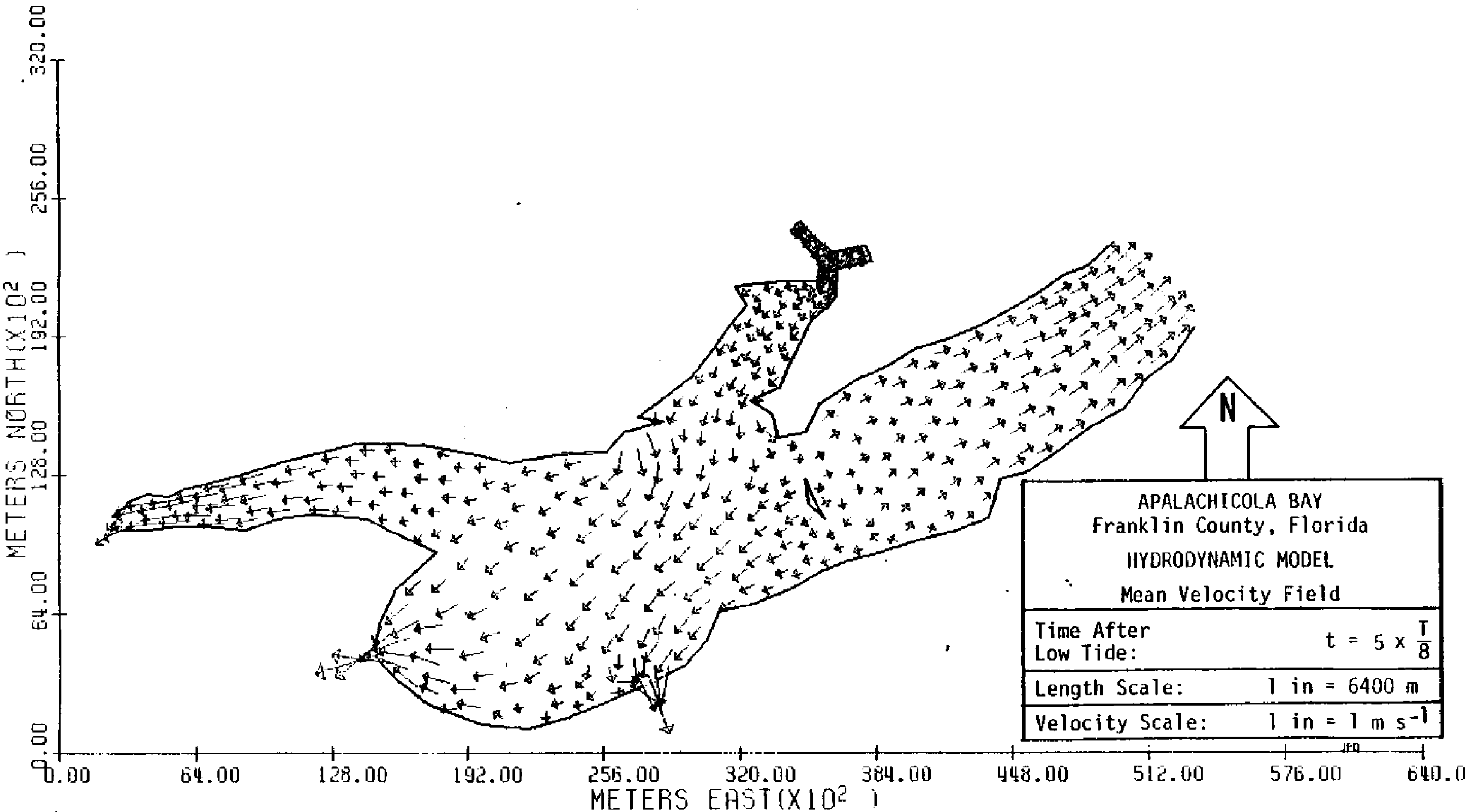


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 3 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

SEP 4

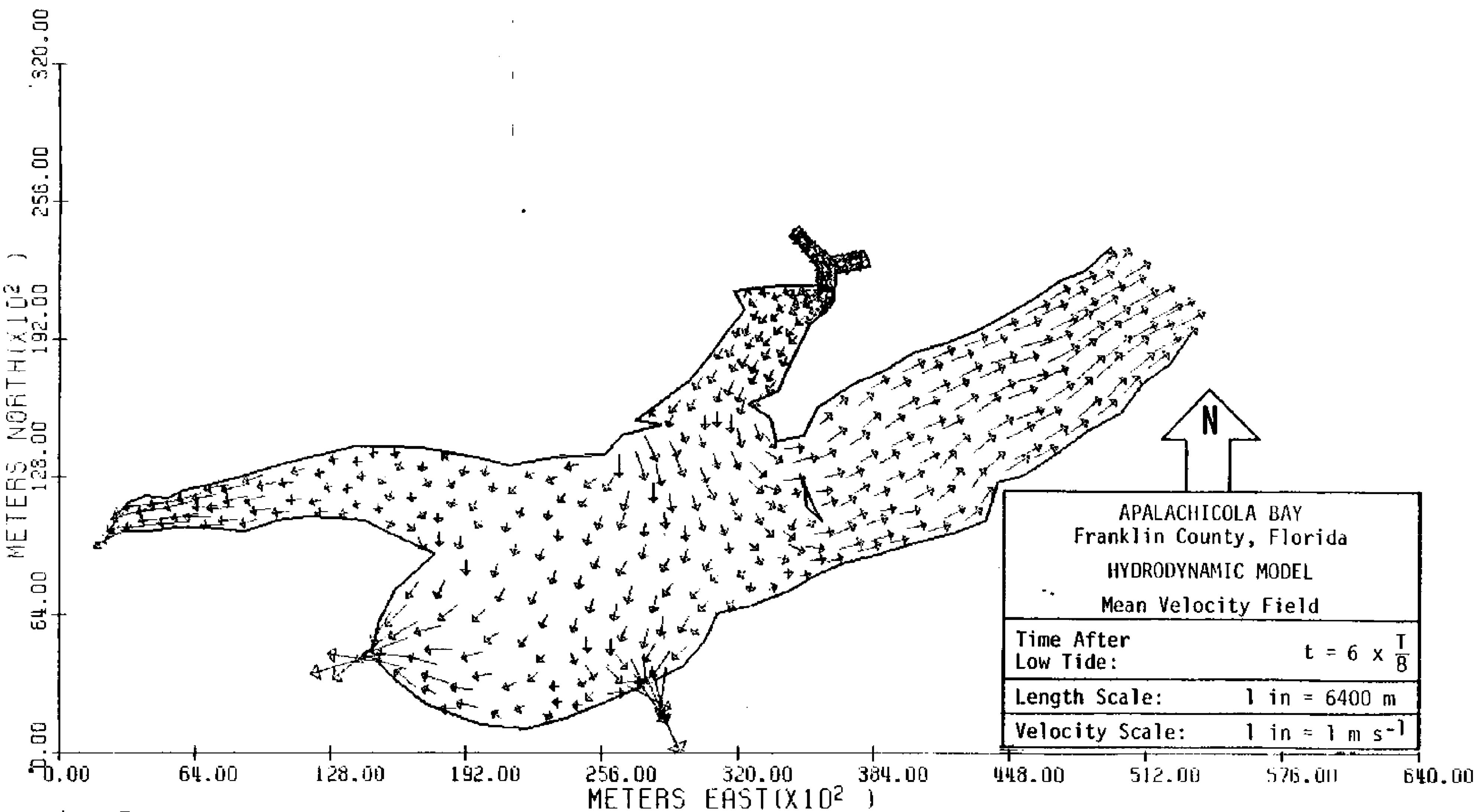

APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 4 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

SEP 5

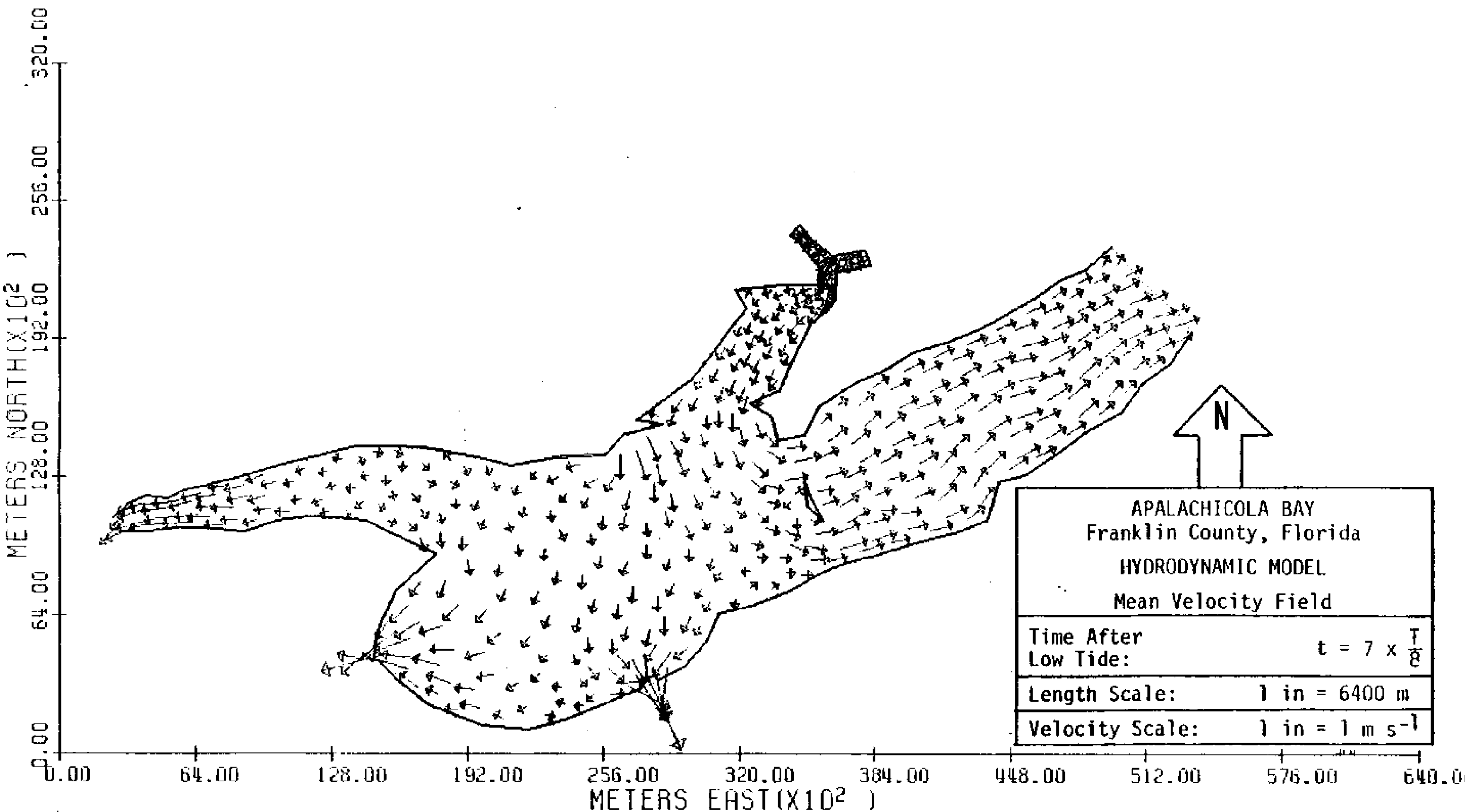


320.00
256.00
192.00
128.00
64.00
0.00
METERS NORTH(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00
METERS EAST(X10²)
N
APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 5 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s⁻¹

SEP 6

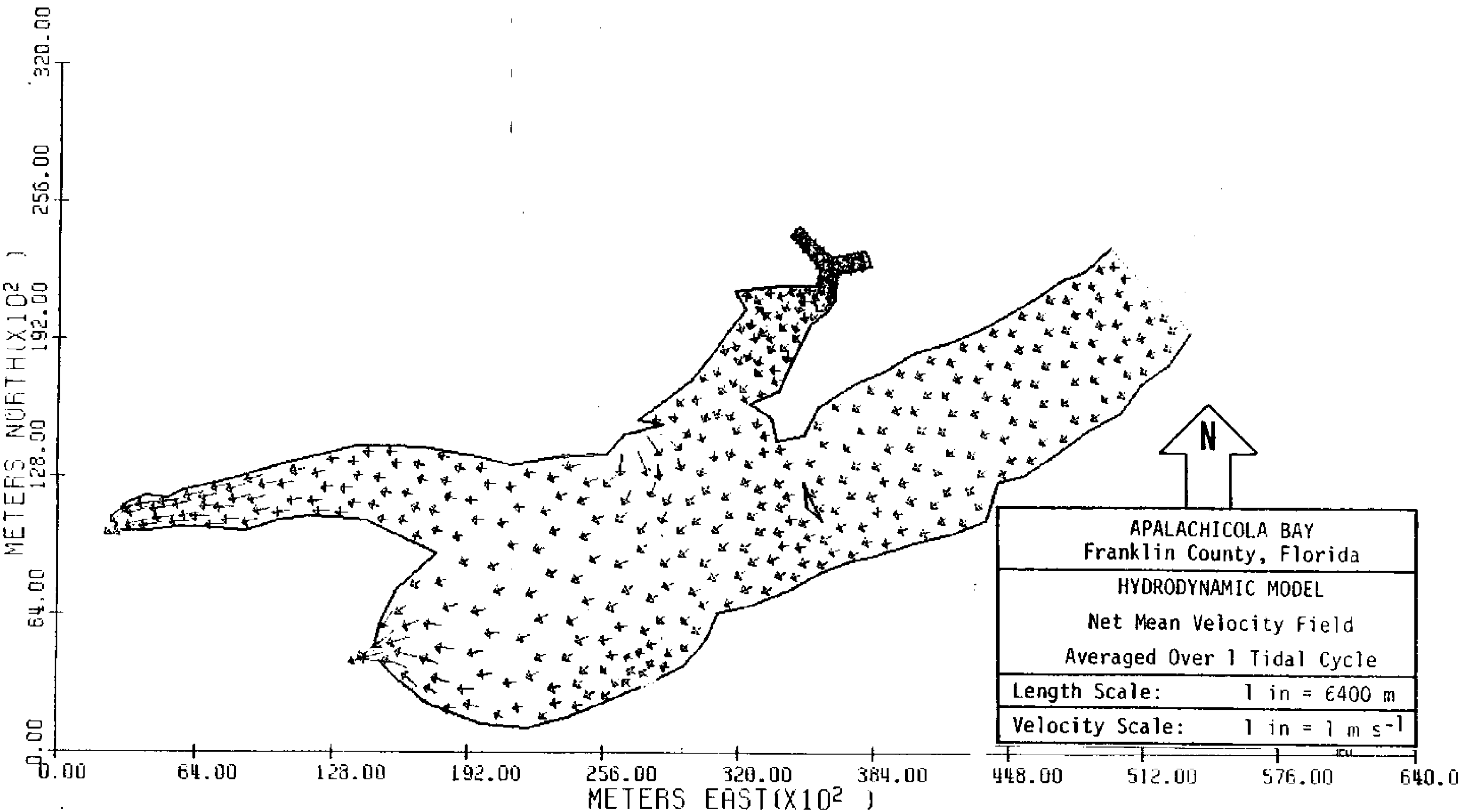

APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 6 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

SEP 7



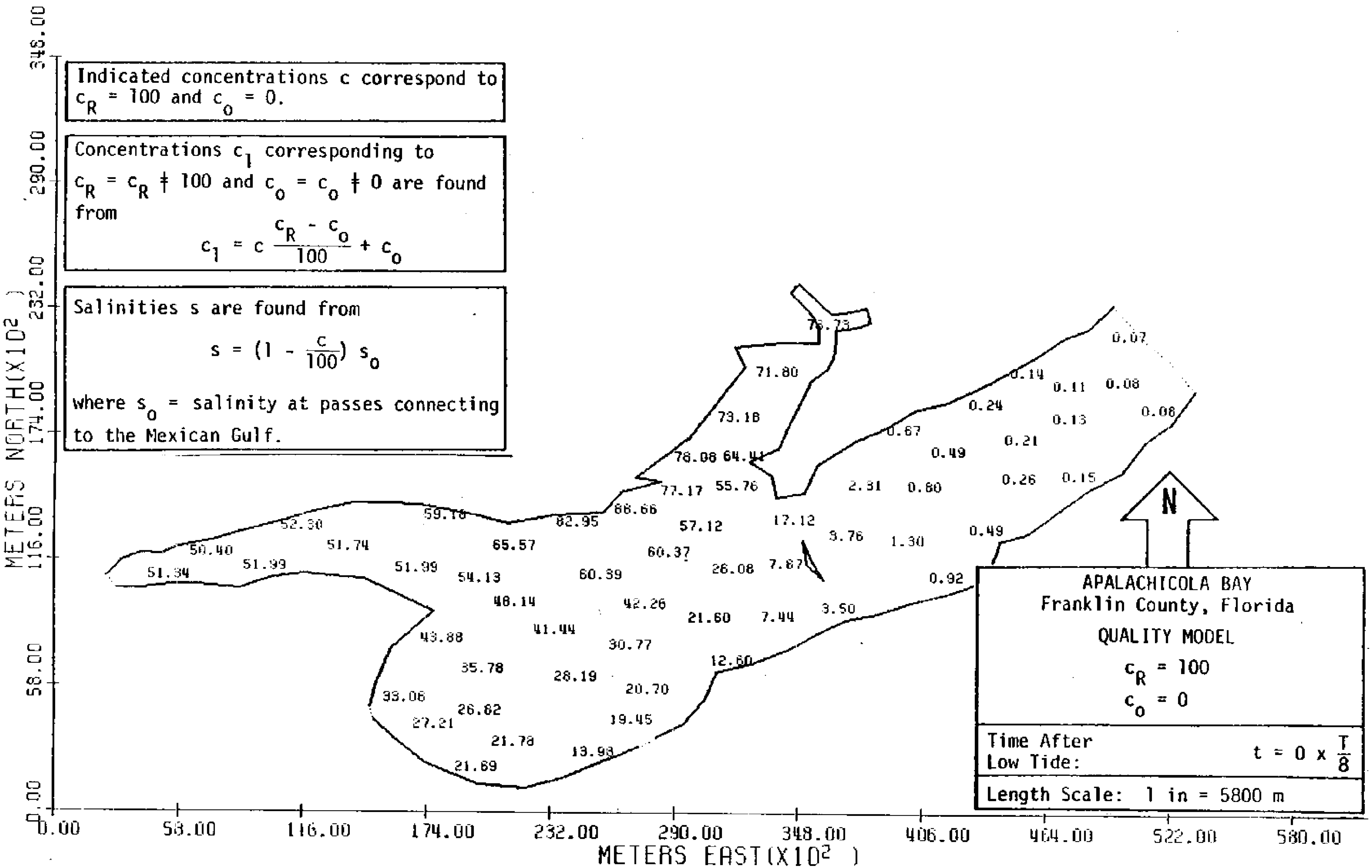
APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide:
t = 7 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

SEP 8

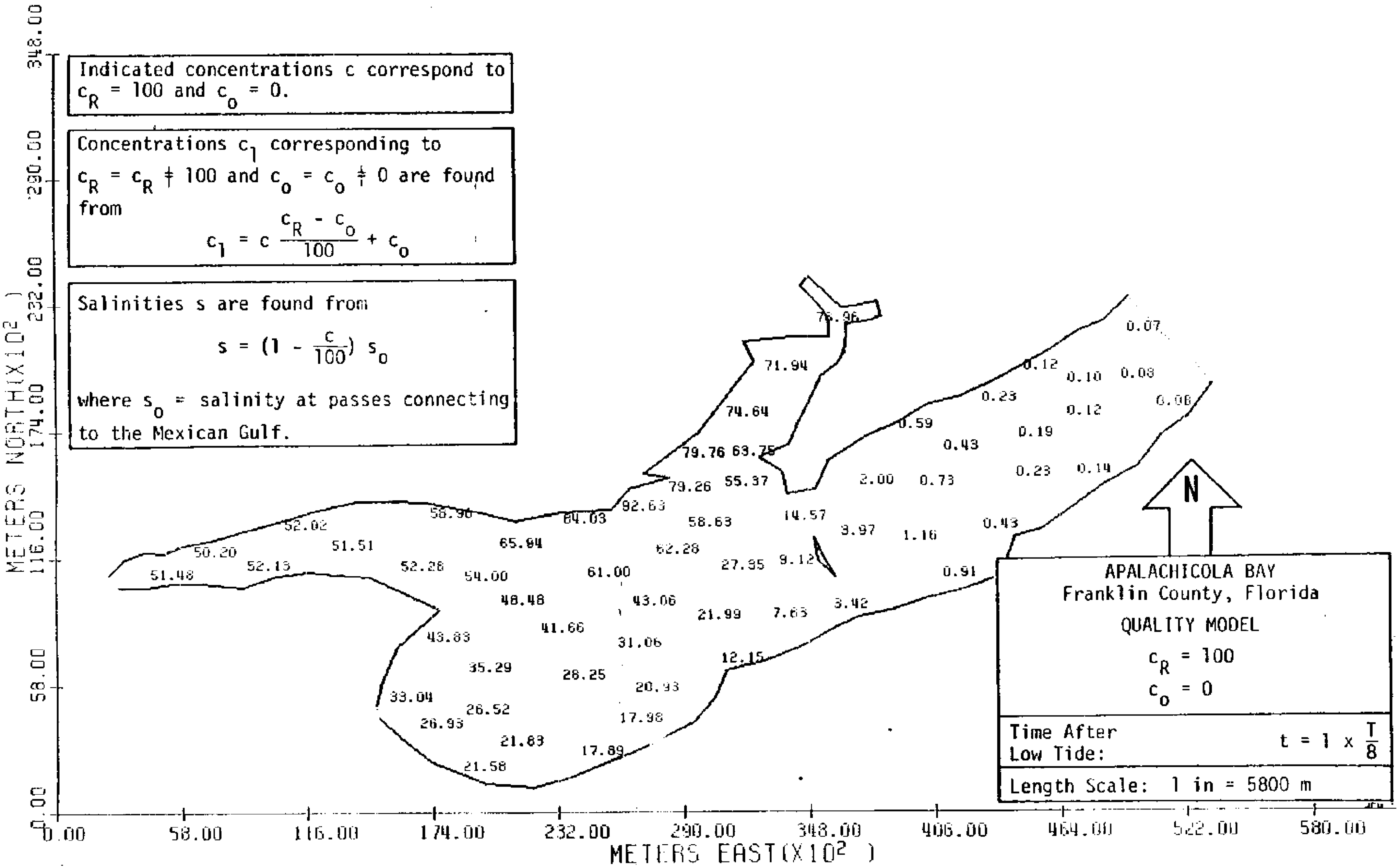


METERS NORTH(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST(X10²)
448.00
512.00
576.00
640.00
N
APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Net Mean Velocity Field
Averaged Over 1 Tidal Cycle
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1

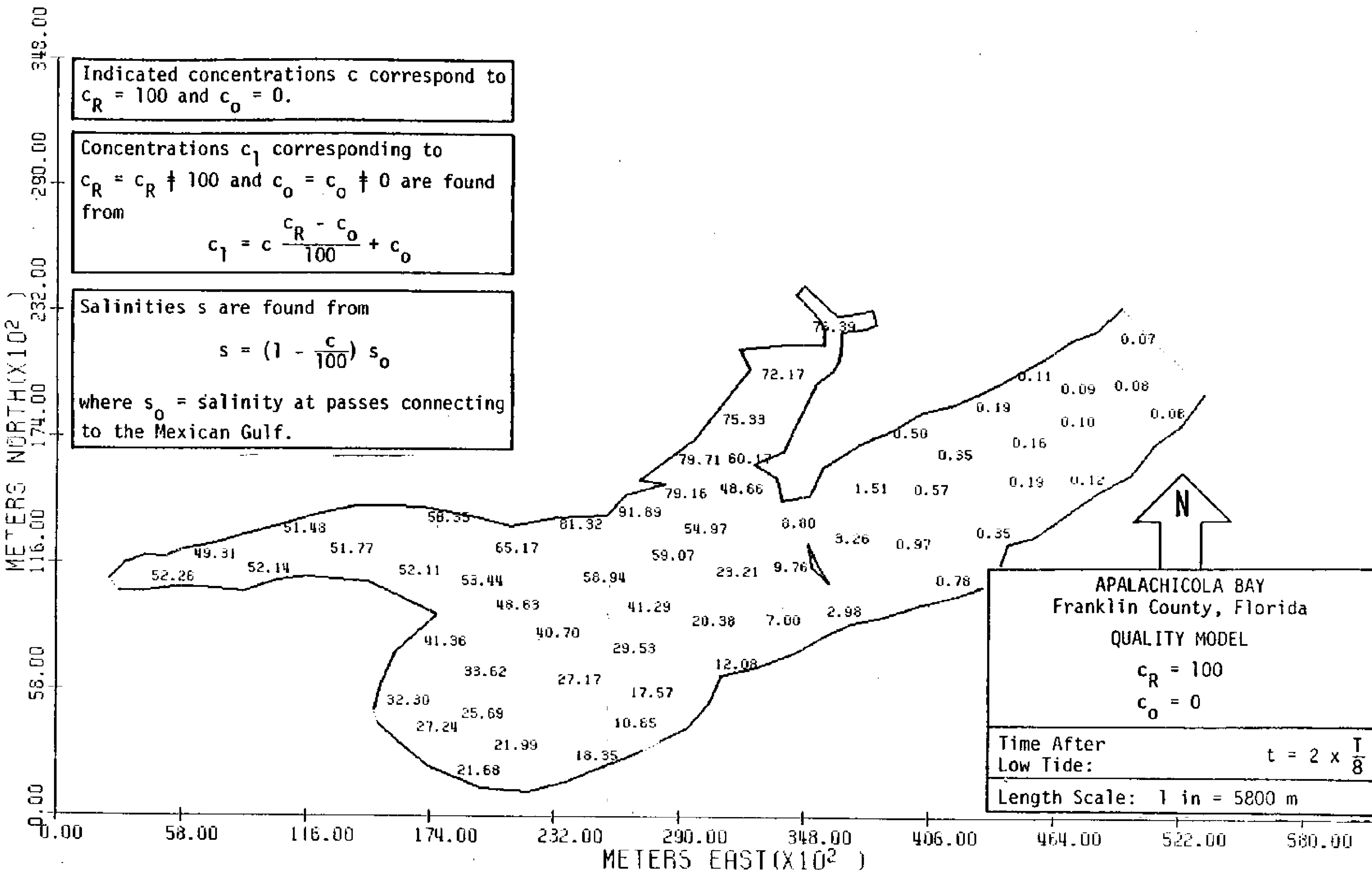
SEP 9


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100})\, s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide: $t = 0 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS EAST(X10²)
METERS NORTH(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00

SEP 10

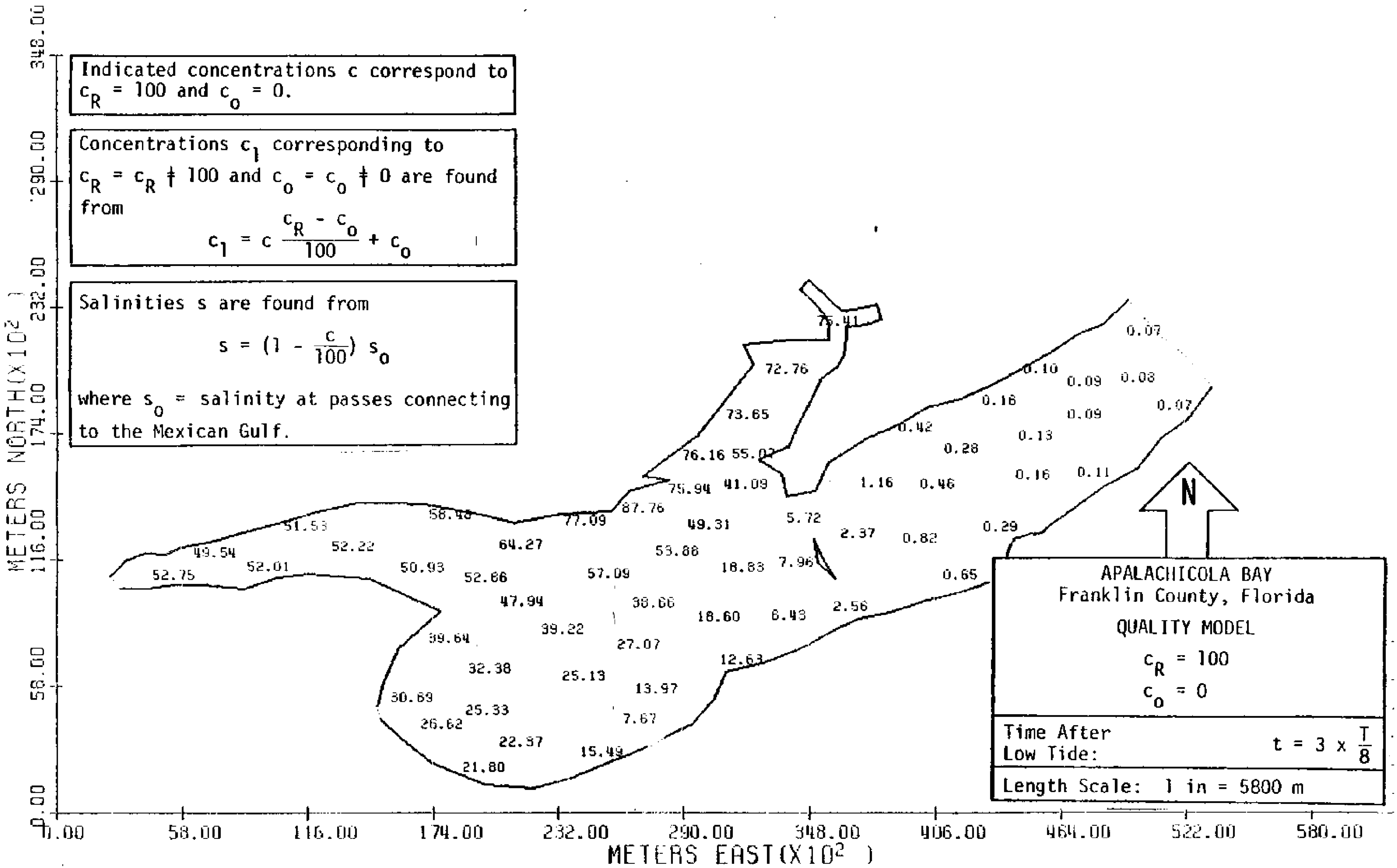

Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c \frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = (1 - \frac{c}{100}) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide: $t = 1 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
76.96
71.94
74.64
79.76 63.75
79.26
55.37
0.07
0.12
0.10
0.08
0.23
0.12
0.08
0.59
0.43
0.19
2.00
0.73
0.23
0.14
14.57
3.97
1.16
0.43
92.63
58.63
84.03
58.90
52.02
50.20
51.51
52.13
51.48
52.28
54.00
65.84
61.00
62.28
27.35
9.12
0.91
48.48
43.06
21.99
7.63
3.42
43.83
41.66
31.06
35.29
28.25
12.15
20.93
33.04
26.52
26.93
17.98
21.83
17.89
21.58
METERS NORTH(X10^2)
348.00
290.00
232.00
174.00
116.00
58.00
0.00
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00

SEP 11

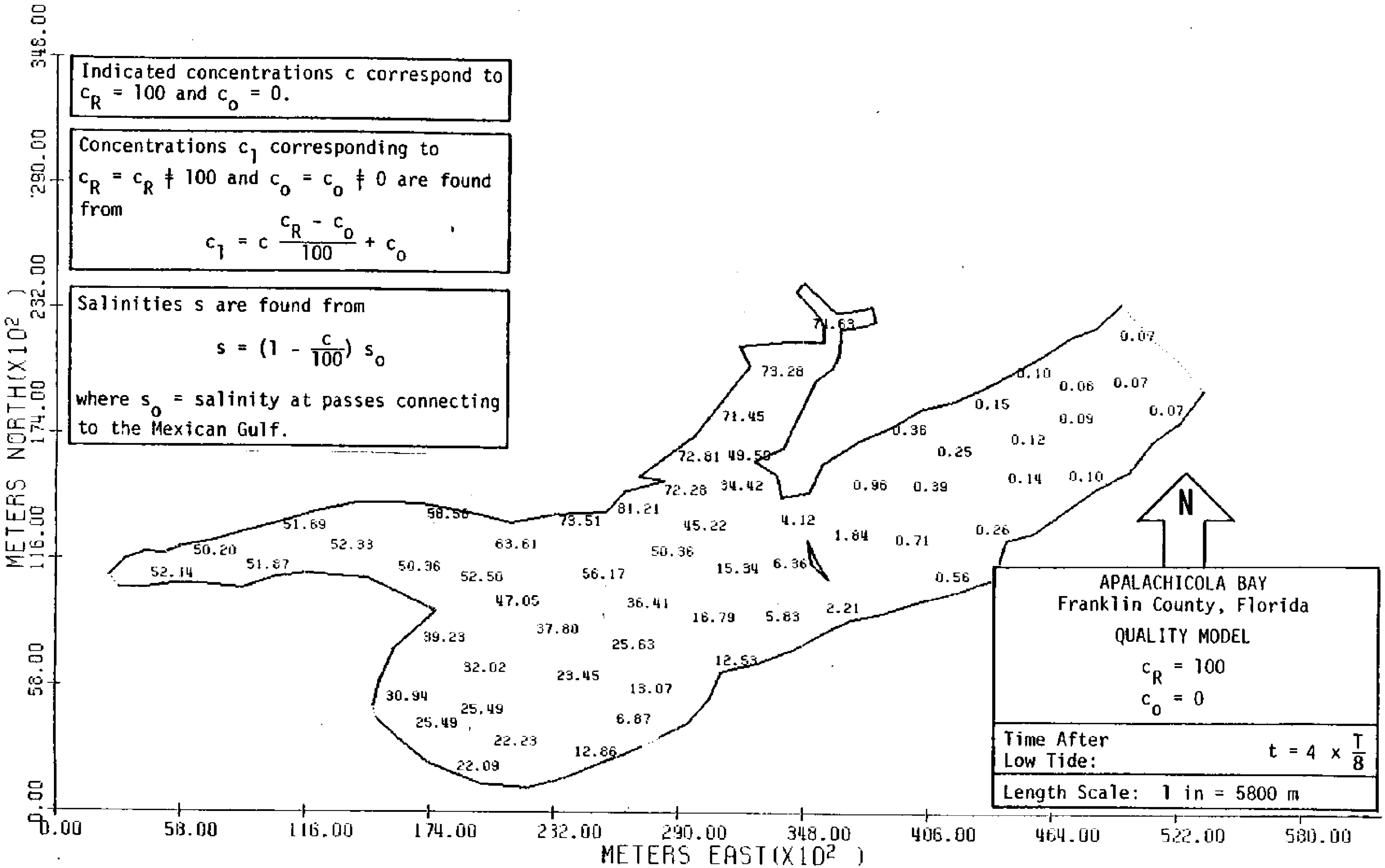


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 2 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00

SEP 12

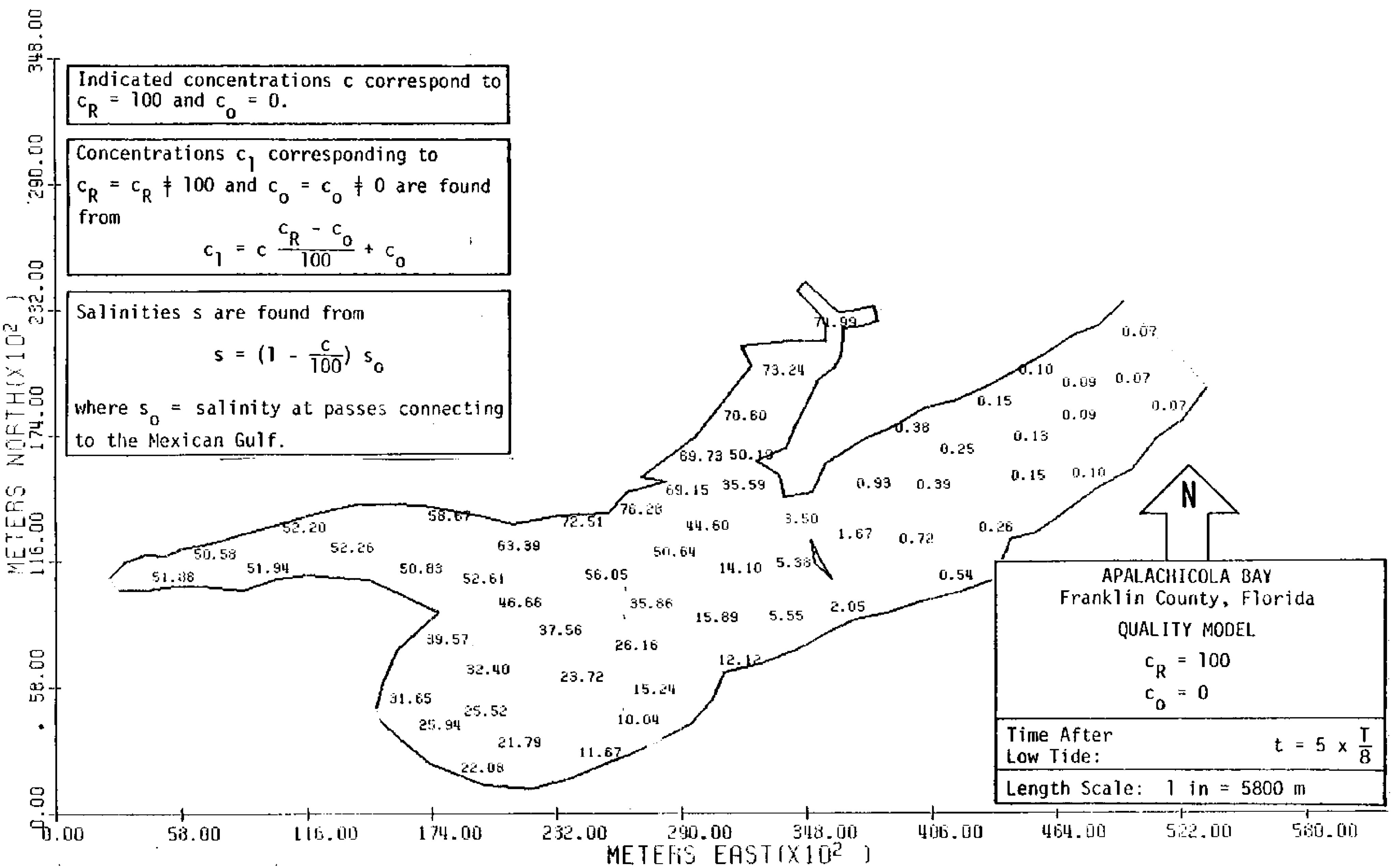

Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R ǂ 100$ and $c_o = c_o ǂ 0$ are found from
$$c_1 = c \frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = (1 - \frac{c}{100}) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide: $t = 3 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
75.41
72.76
73.65
76.16
55.02
75.94
41.09
87.76
77.09
58.48
51.53
49.54
52.75
52.01
52.22
50.93
64.27
52.66
47.94
57.09
49.31
53.88
38.66
39.22
39.64
32.38
25.13
27.07
18.83
18.60
5.72
7.96
6.43
12.63
13.97
7.67
30.69
25.33
26.62
22.57
15.49
21.80
2.37
2.56
1.16
0.46
0.82
0.65
0.29
0.42
0.28
0.16
0.13
0.16
0.11
0.10
0.09
0.09
0.08
0.07
0.07

SEP 13



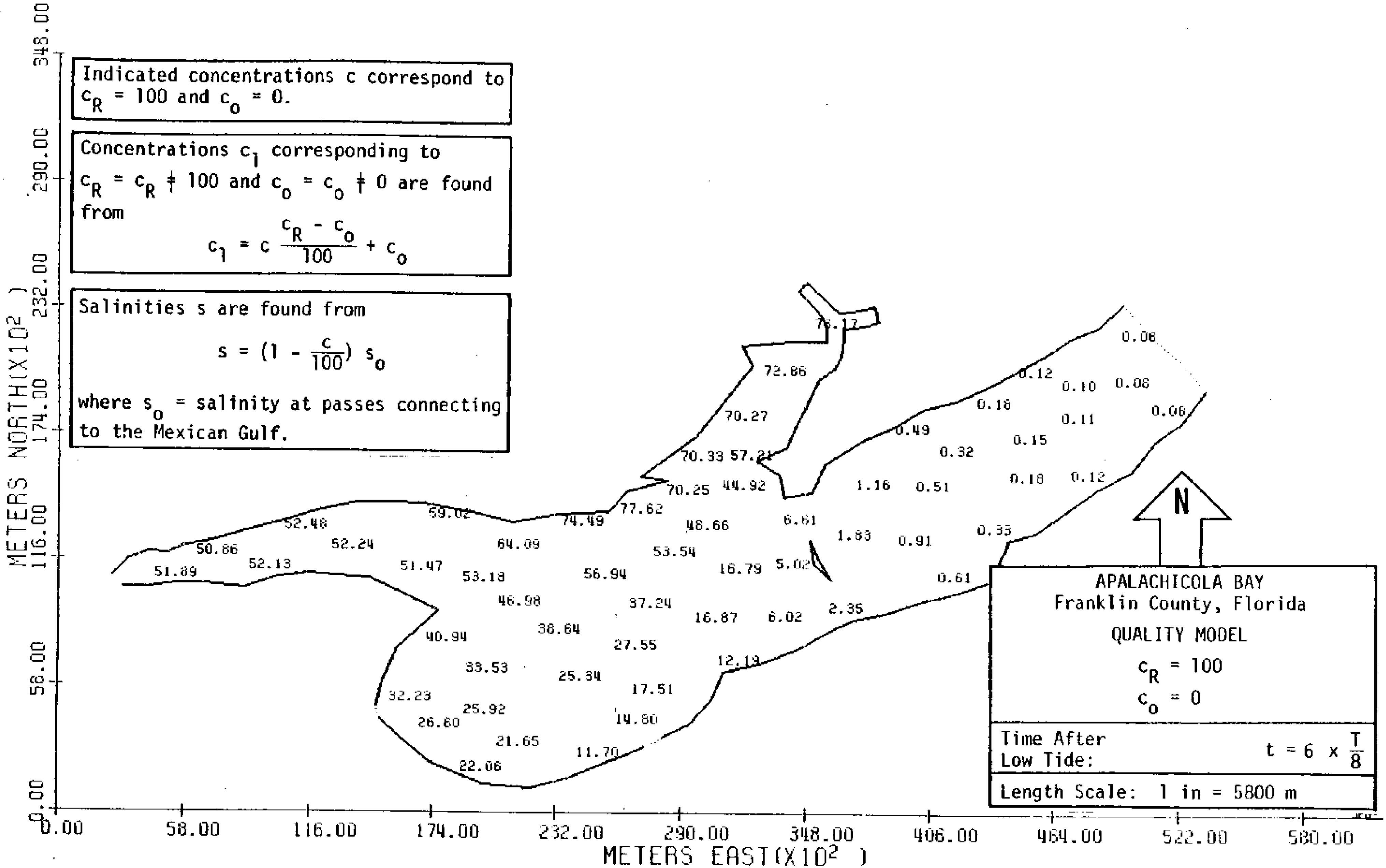
Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c\,\frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = \left(1 - \frac{c}{100}\right) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide: $t = 4 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
52.14
50.20
51.87
51.69
52.33
50.36
58.56
52.50
63.61
47.05
39.23
37.80
32.02
30.94
25.49
25.49
22.23
22.09
73.51
56.17
81.21
50.36
36.41
25.63
23.45
13.07
6.87
12.86
72.28
72.81
45.22
49.50
34.42
71.45
73.28
71.63
15.34
16.79
5.83
12.53
4.12
6.36
2.21
1.84
0.96
0.71
0.39
0.36
0.25
0.56
0.26
0.15
0.12
0.14
0.10
0.10
0.06
0.09
0.07
0.07
0.07

SEP 14

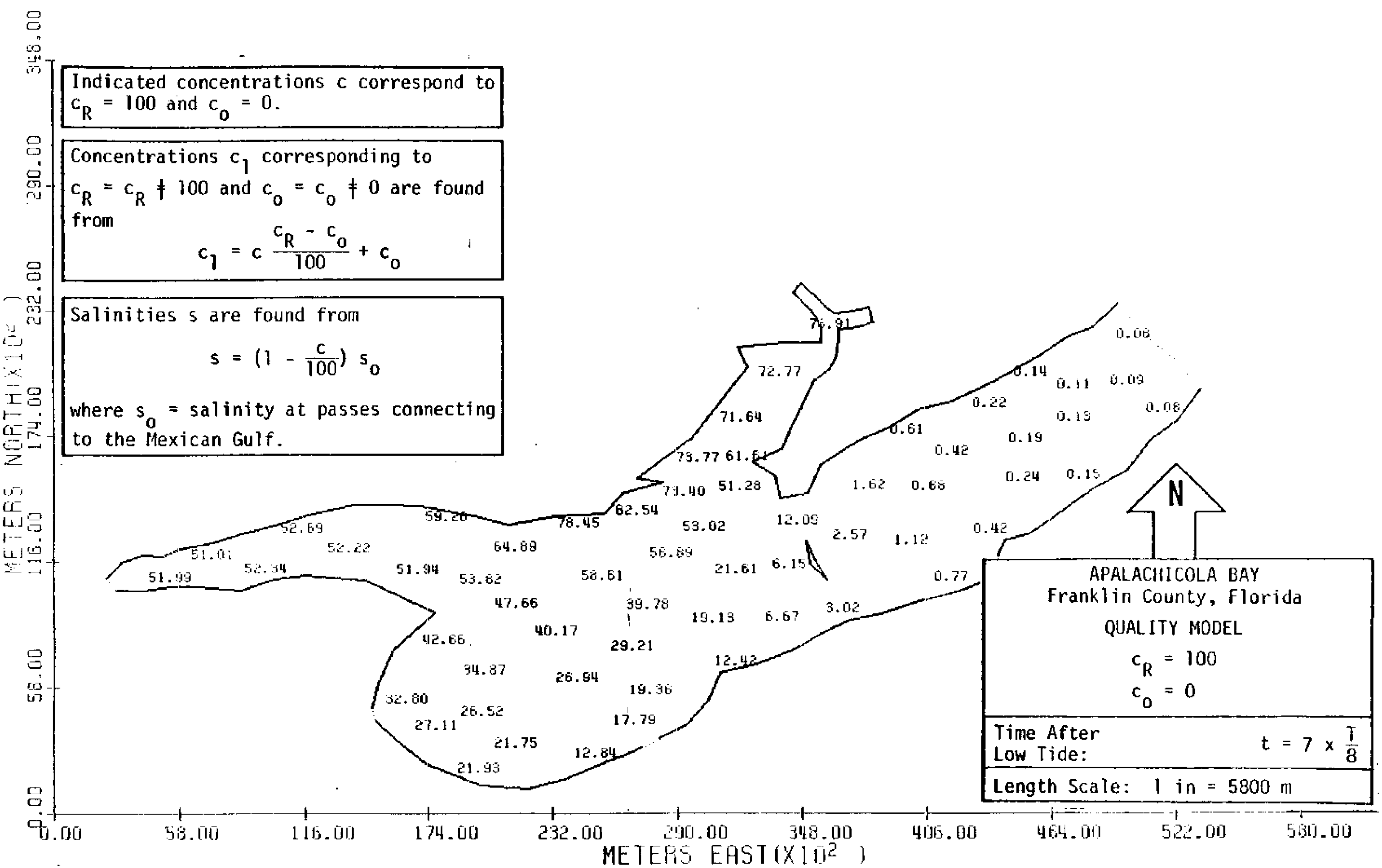


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c \frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = (1 - \frac{c}{100})\, s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide: $t = 5 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
71.99
73.24
70.60
69.73
50.19
69.15
35.59
76.28
72.51
58.67
52.20
50.58
51.88
51.94
52.26
50.83
63.39
52.61
46.66
56.05
44.60
50.64
35.86
14.10
5.38
3.50
1.67
0.93
0.72
0.39
0.38
0.25
0.15
0.13
0.10
0.09
0.07
0.26
0.54
2.05
5.55
15.89
12.12
26.16
37.56
39.57
32.40
23.72
15.24
10.04
31.65
25.94
25.52
21.79
22.08
11.67

SEP 15


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100})\, s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide: $t = 6 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
51.89
50.86
52.13
52.48
52.24
59.02
51.47
64.09
53.18
74.49
46.98
40.94
38.64
33.53
32.23
25.92
26.80
21.65
22.06
25.34
17.51
14.80
11.70
27.55
37.24
56.94
77.62
70.25
44.92
48.66
53.54
16.79
16.87
6.02
12.19
70.33
57.21
70.27
72.86
76.17
6.61
5.02
1.83
2.35
1.16
0.51
0.91
0.61
0.49
0.32
0.33
0.18
0.15
0.12
0.10
0.11
0.08
0.06

SEP 16

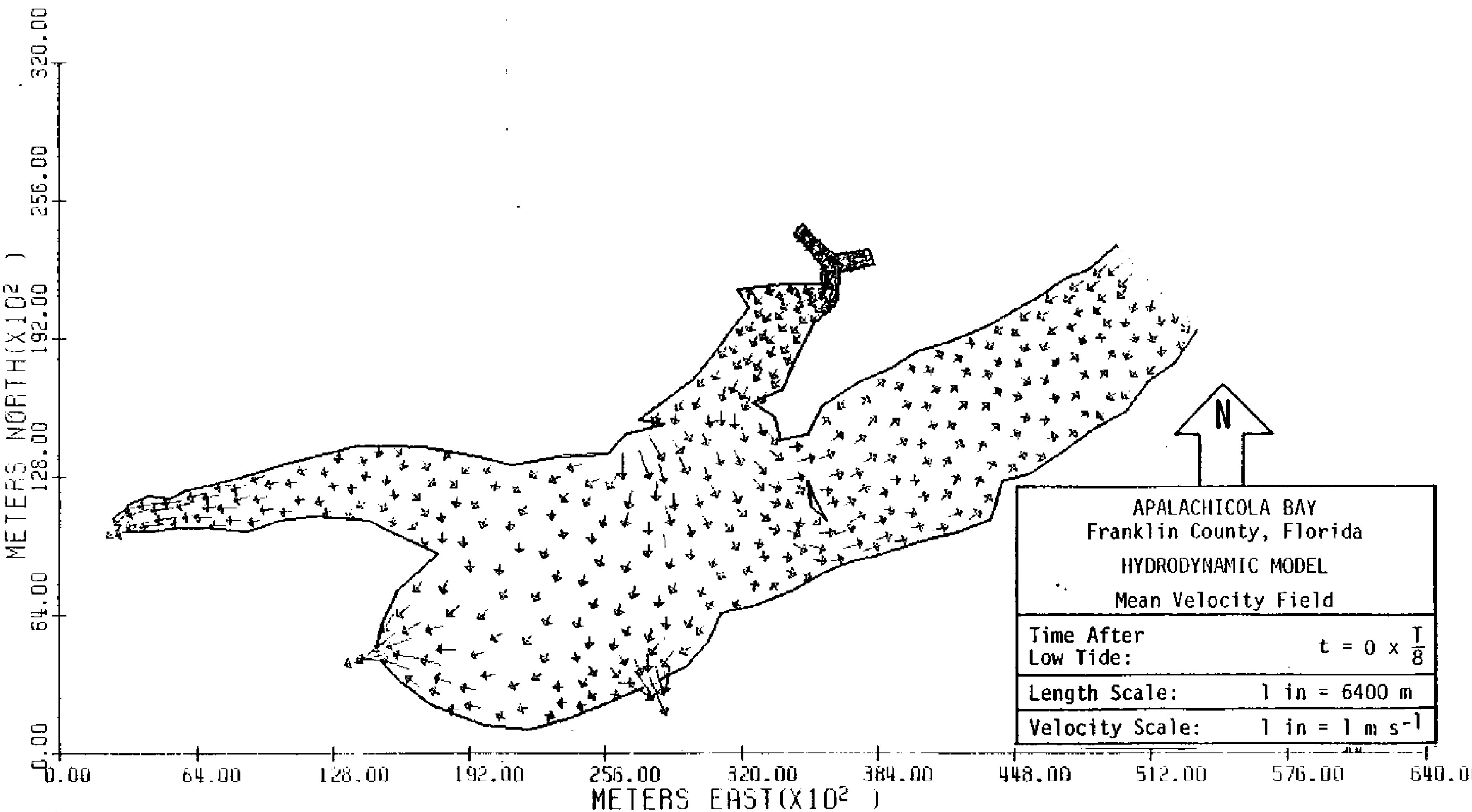


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 7 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS EAST(X10²)
METERS NORTH(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00

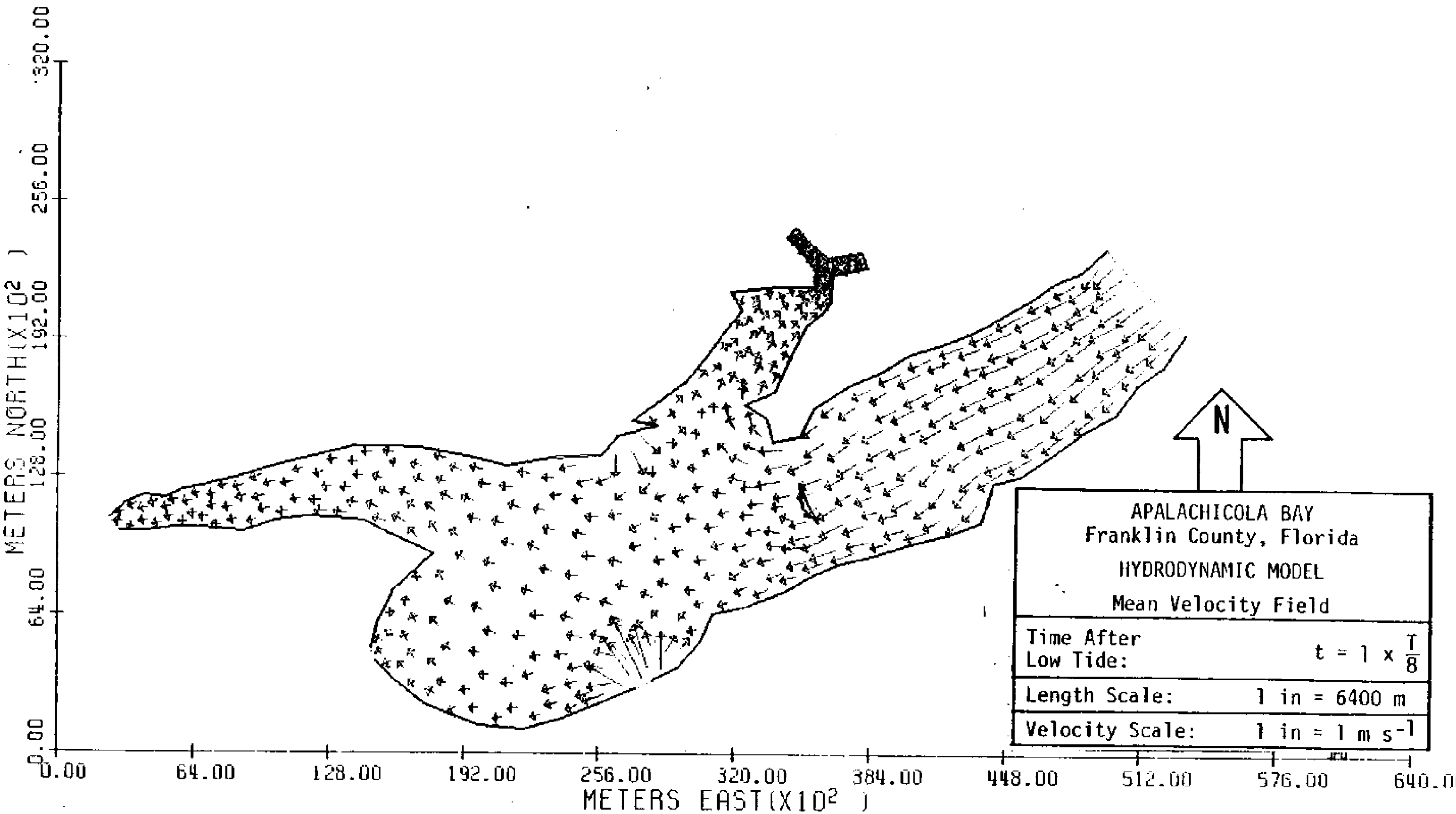
SEP 17

OCTOBER

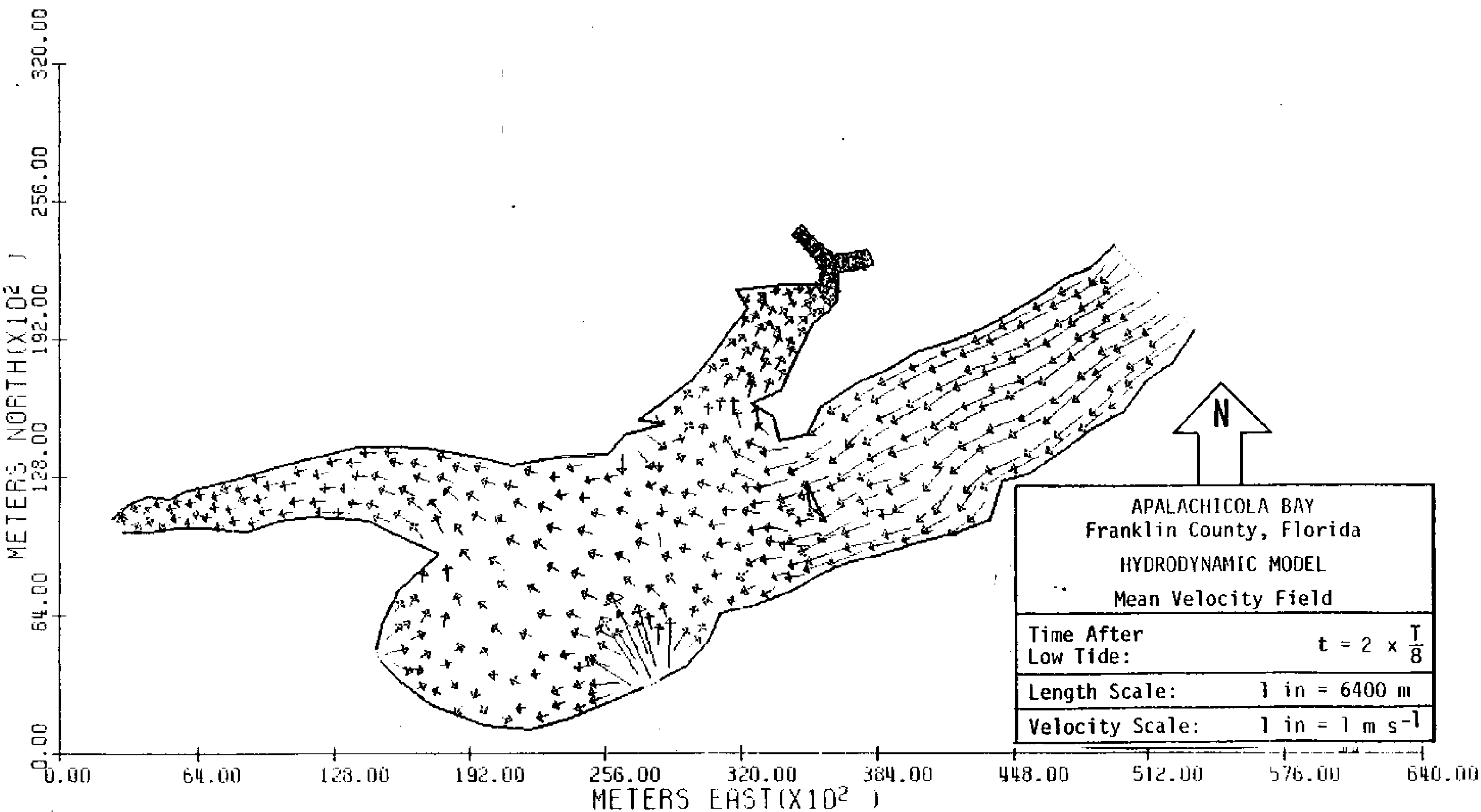
OCT 1 through OCT 8:	Vertically averaged velocities v_m given at time increments equal to one eighth of the tidal period beginning at low tide.
OCT 9:	Net values of vertically averaged velocities. Time averaged over one tidal cycle.
OCT 10 through OCT 17:	Vertically averaged pollutant concentration corresponding to river concentration $c_R = 100$ and concentration $c_o = 0$ at all inlets to bay. Concentrations given at time increments equal to one eighth of the tidal period beginning at low tide.


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 0 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

OCT 1

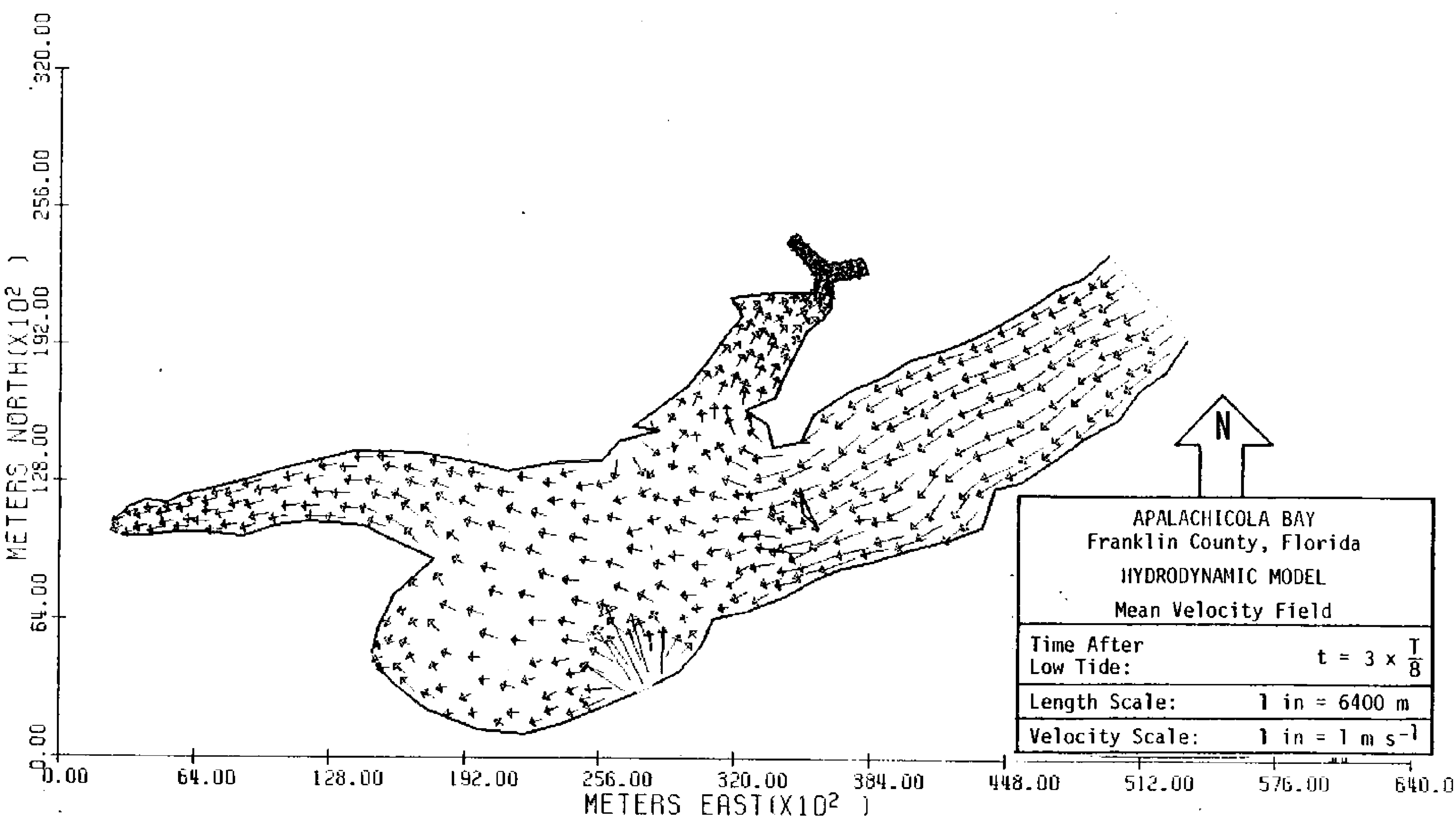

APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 1 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

OCT 2



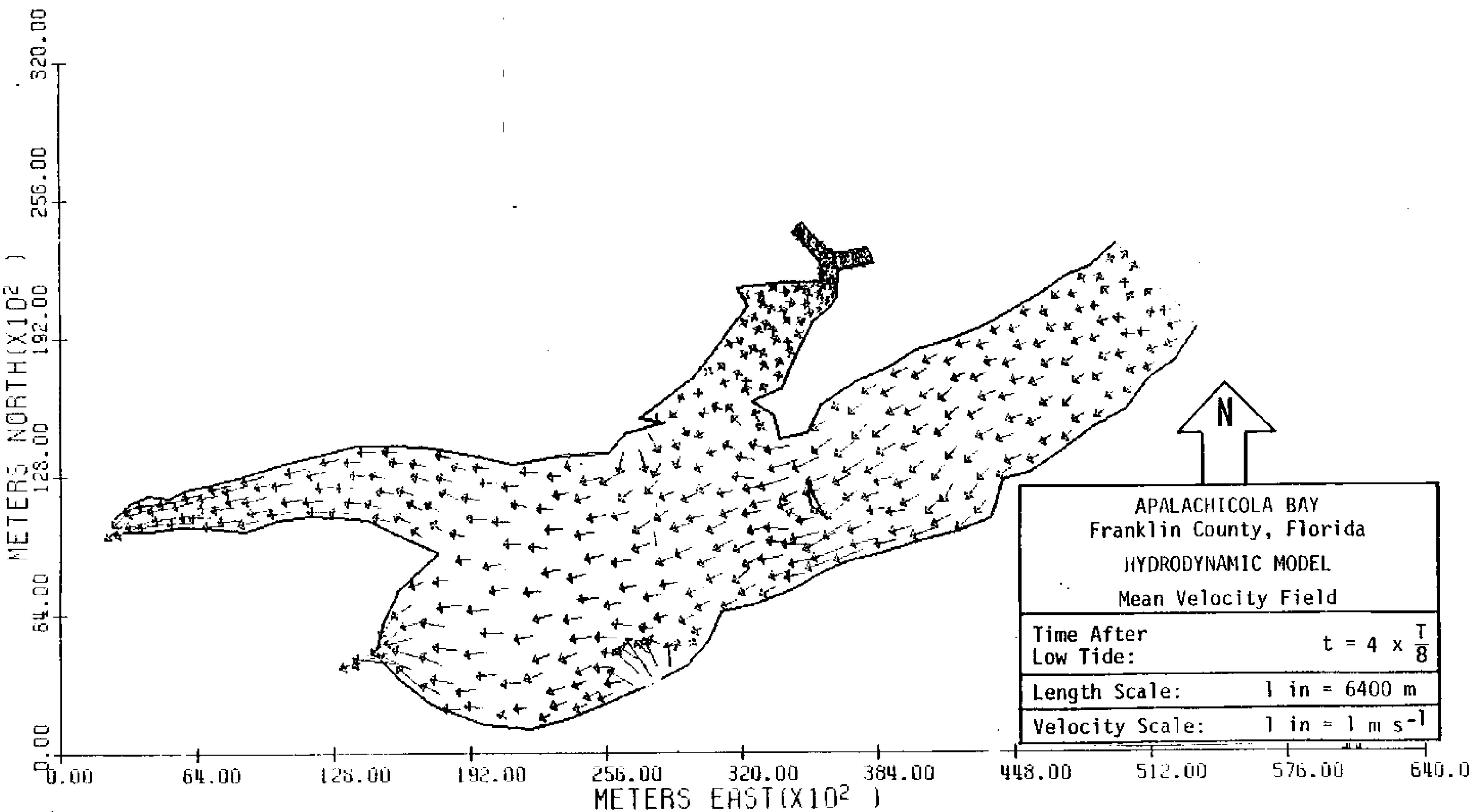
APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide:
$t = 2 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST(X10²)
384.00
448.00
512.00
576.00
640.00

OCT 3

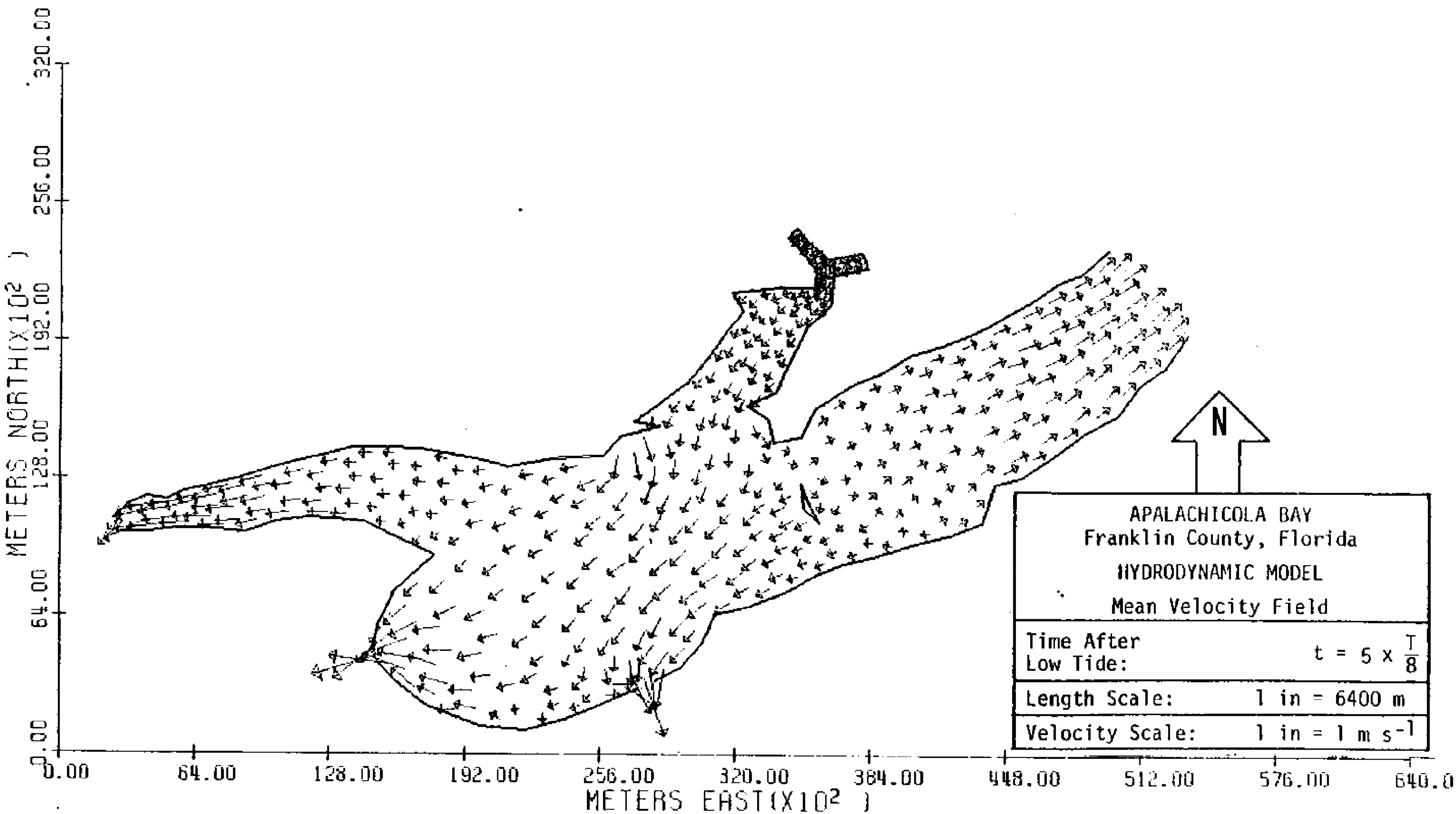


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 3 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH($X10^2$)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST($X10^2$)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

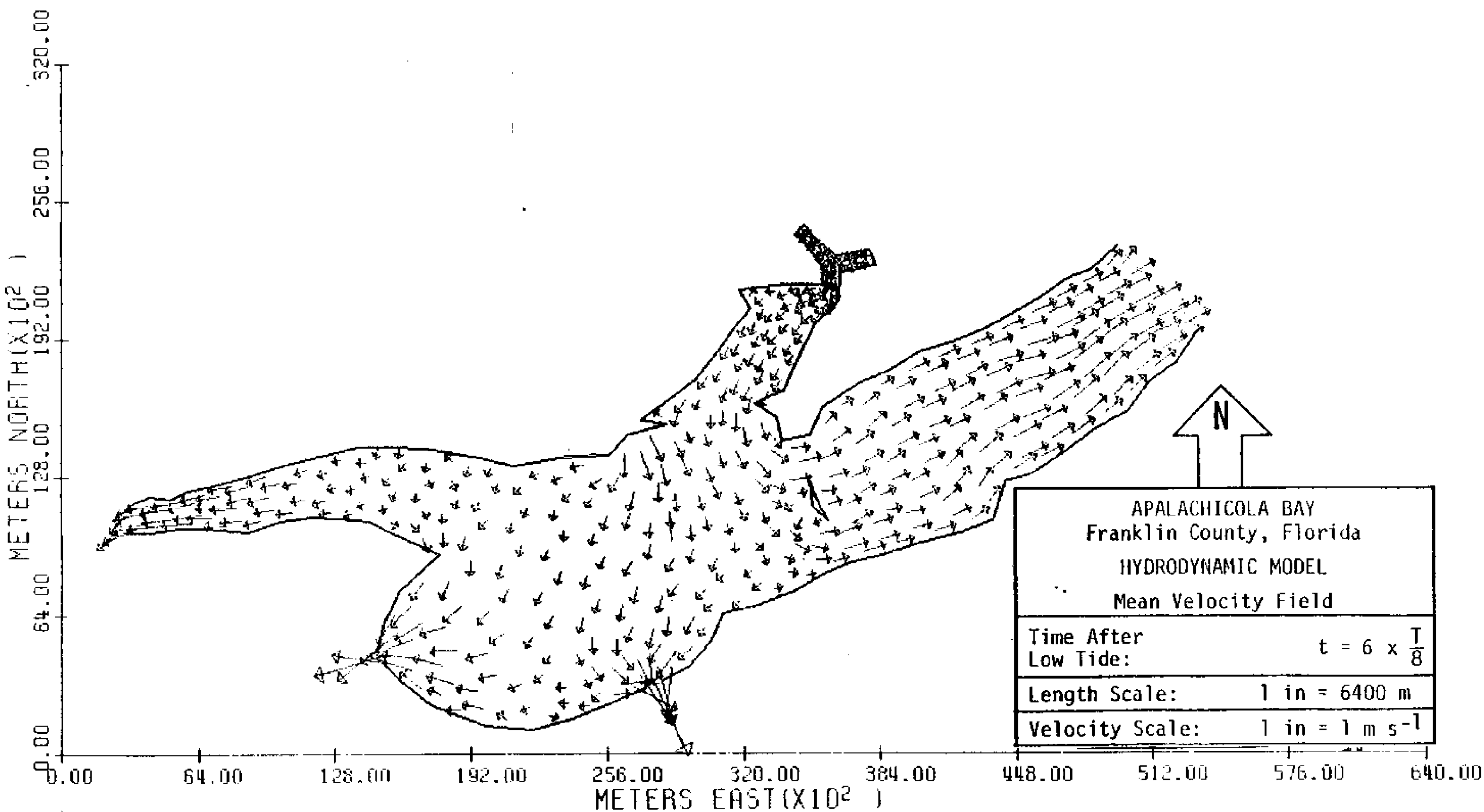
OCT 4


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 4 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

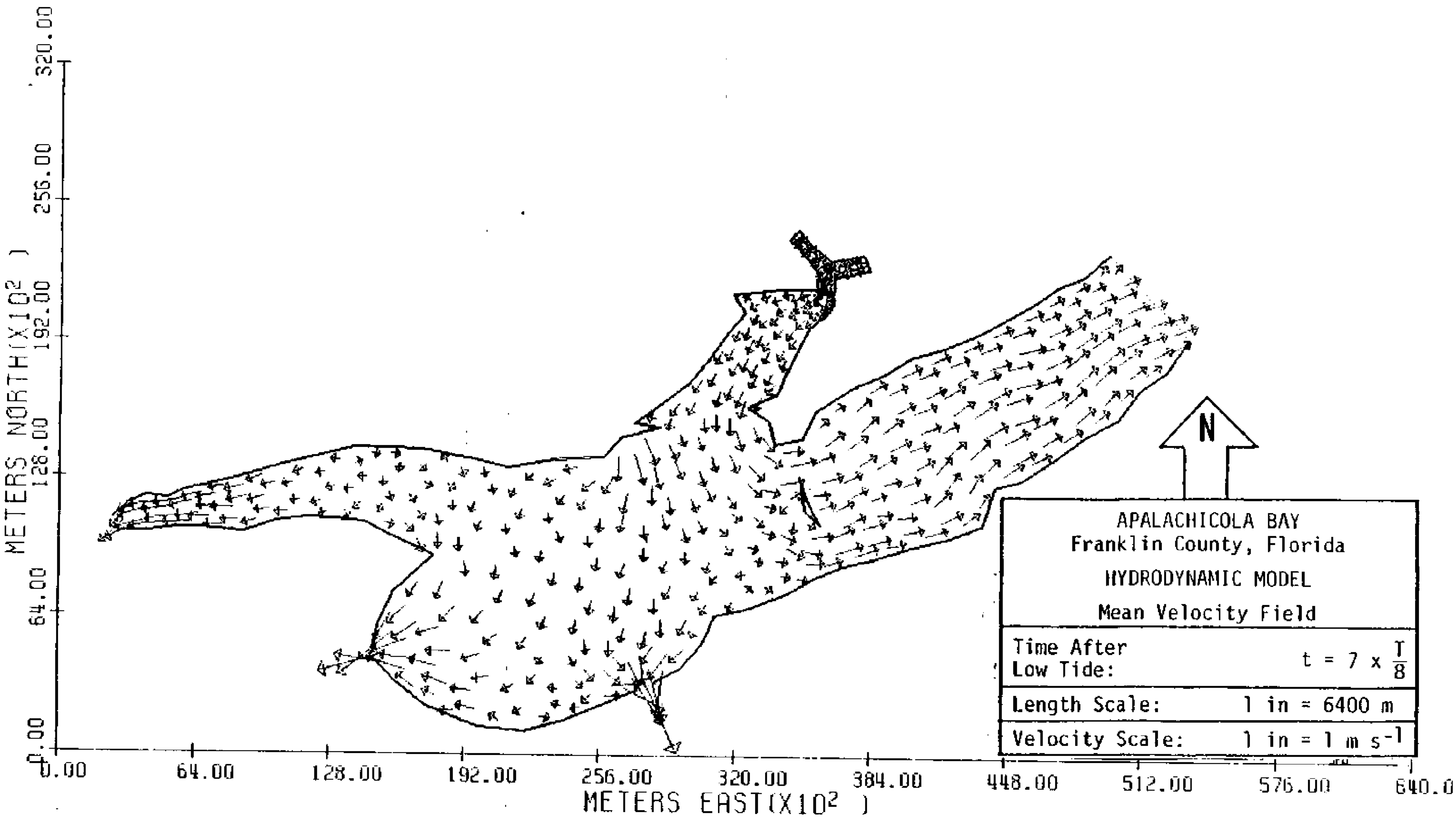
OCT 5


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 5 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH($X10^2$)
METERS EAST($X10^2$)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

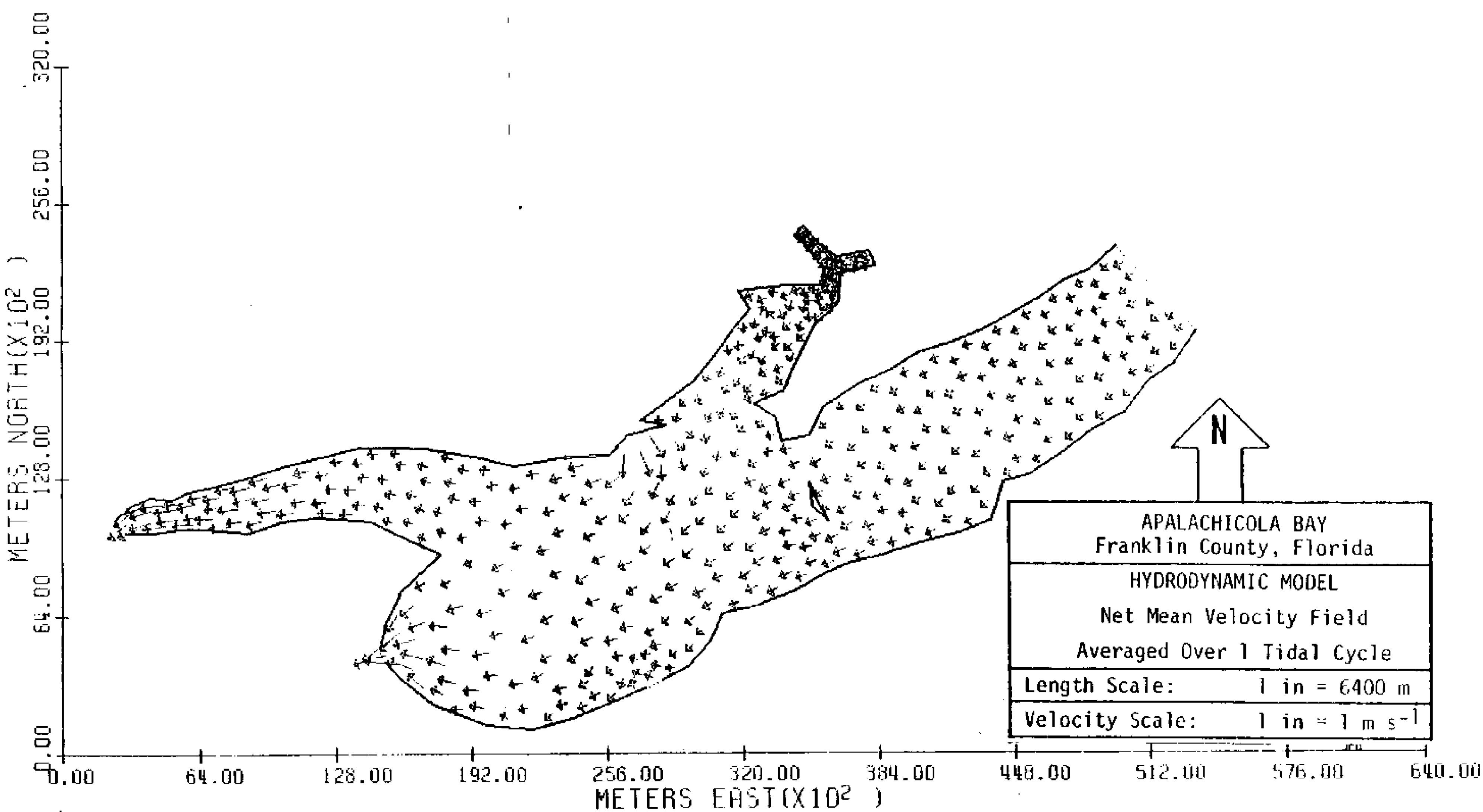
OCT 6


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 6 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

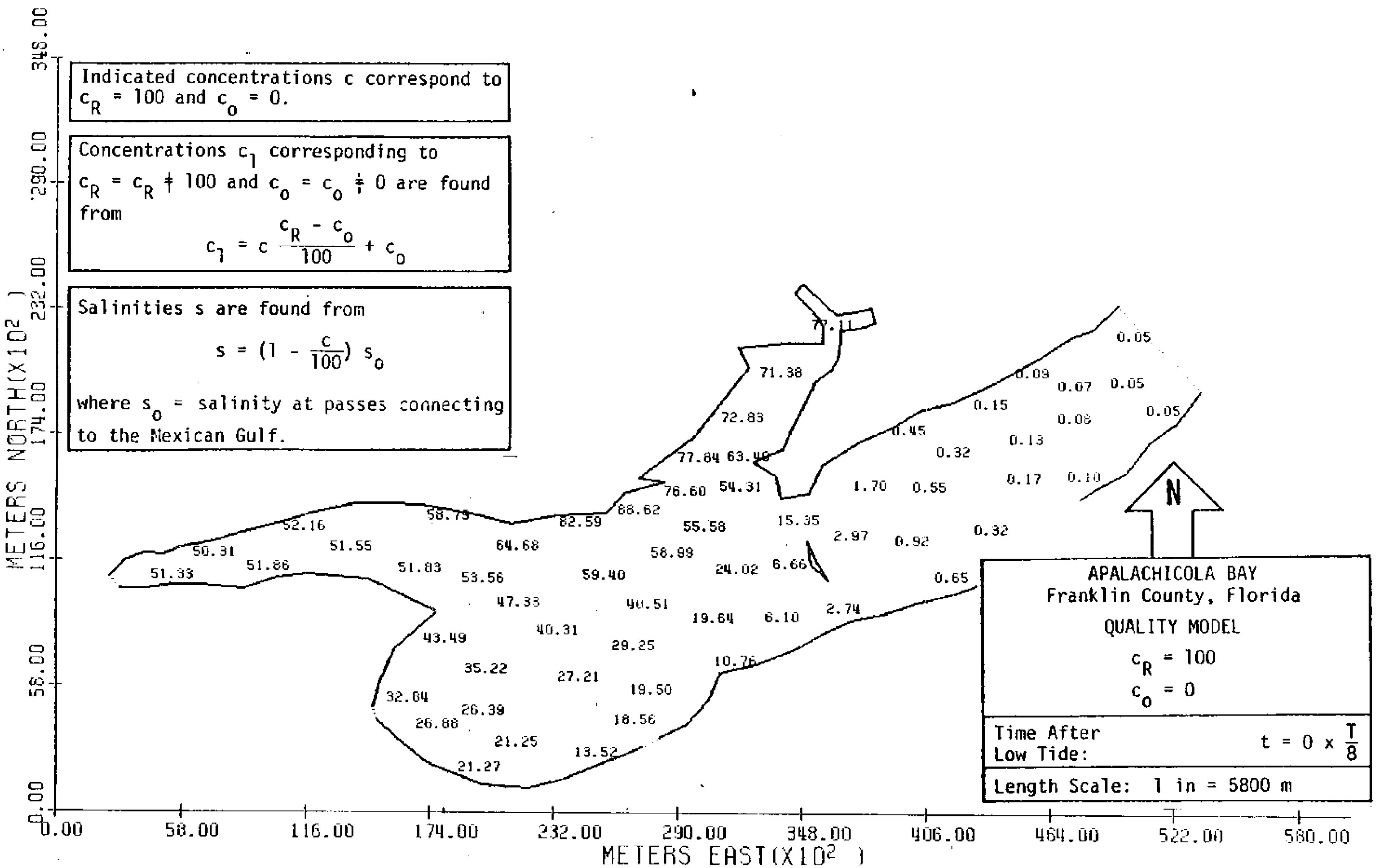
OCT 7


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 7 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

OCT 8

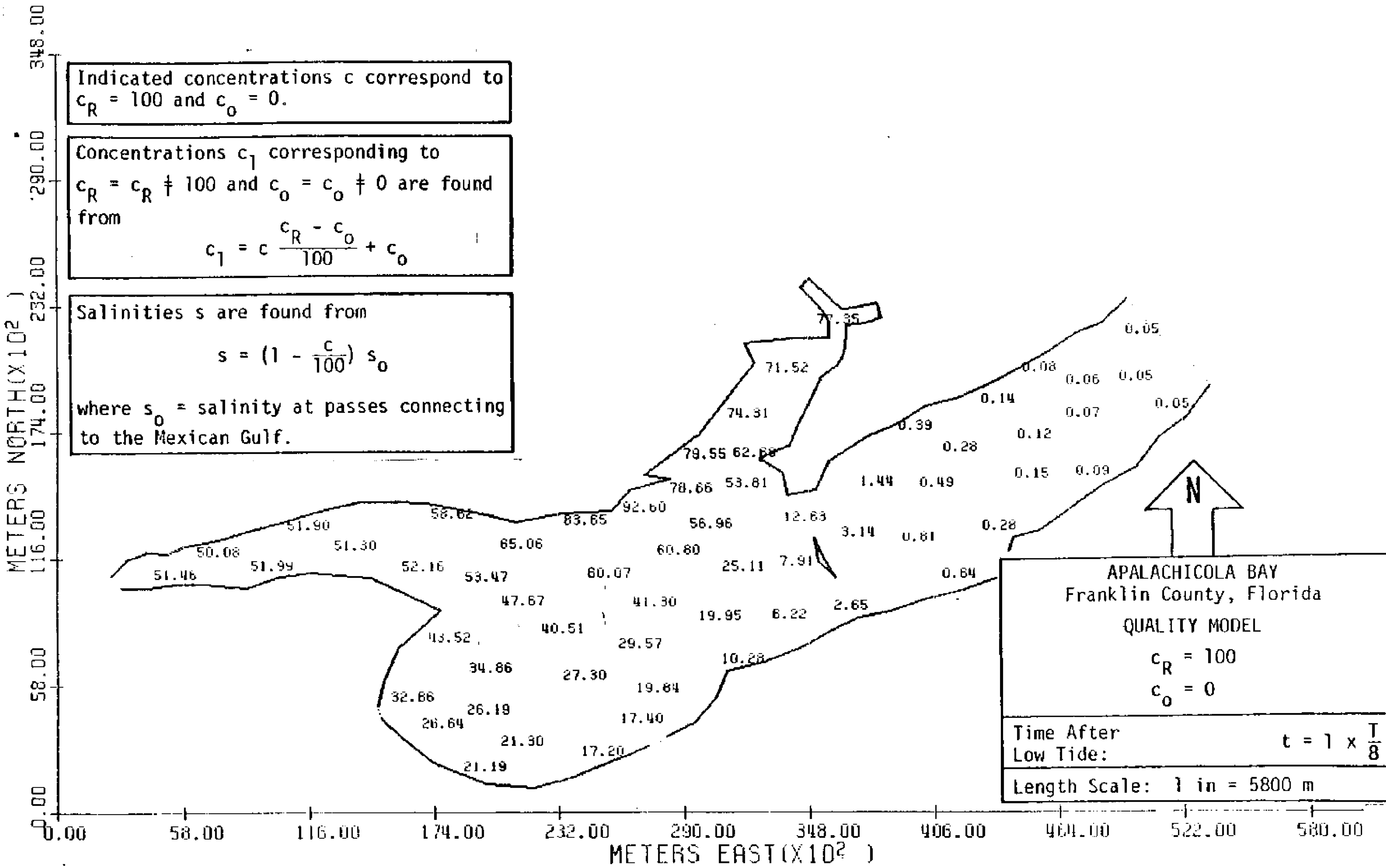

APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Net Mean Velocity Field
Averaged Over 1 Tidal Cycle
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s⁻¹
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

OCT 9

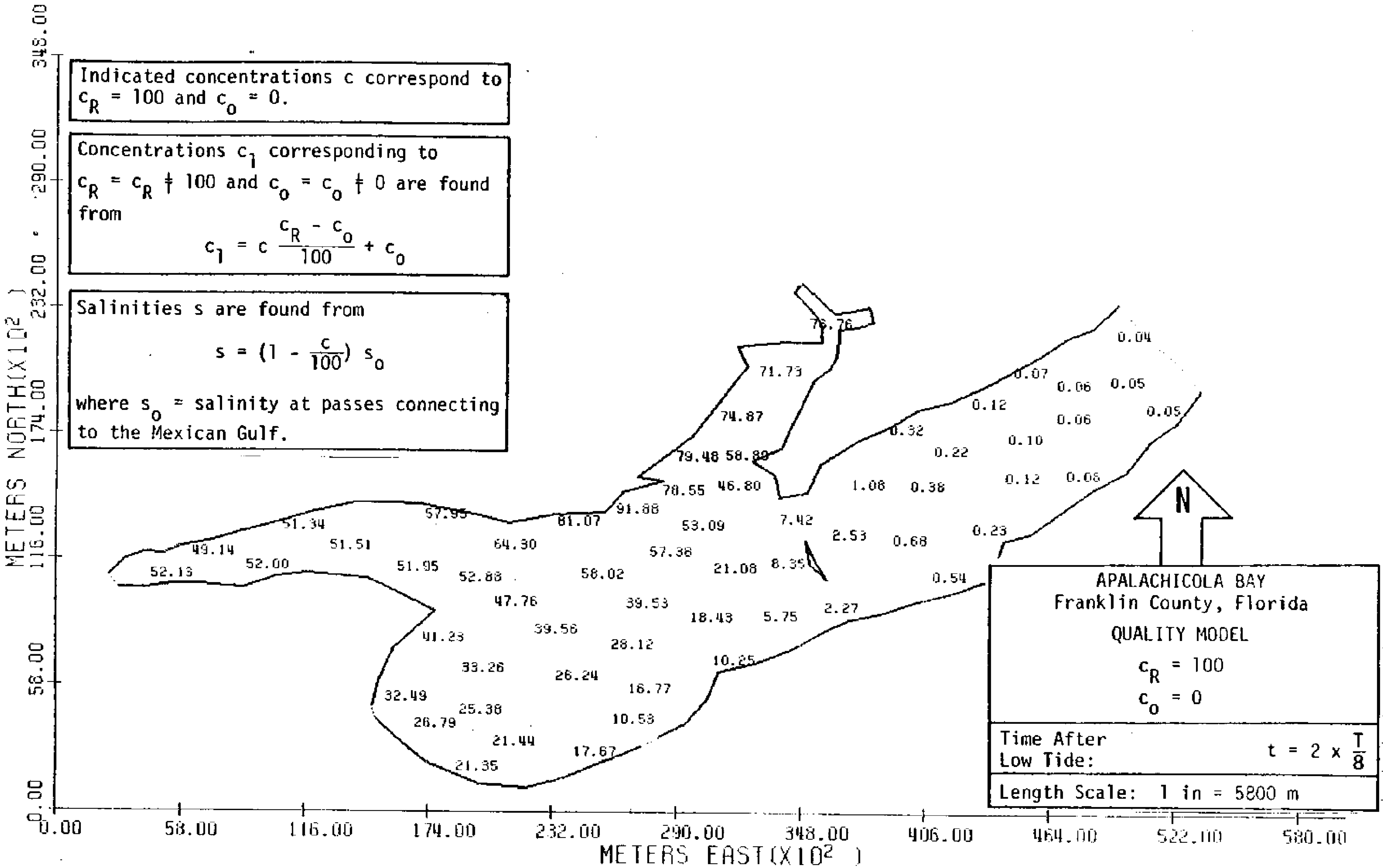


Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100})\, s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide:
$t = 0 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH($X10^2$)
METERS EAST($X10^2$)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
51.33
50.31
51.86
52.16
51.55
51.83
58.75
53.56
64.68
47.33
43.49
40.31
35.22
32.84
26.88
26.39
21.27
21.25
27.21
13.52
18.56
19.50
29.25
59.40
82.59
88.62
76.60
77.84
63.46
72.83
71.38
54.31
55.58
58.99
40.51
19.64
24.02
6.66
6.10
2.74
10.76
15.35
2.97
1.70
0.55
0.92
0.45
0.32
0.65
0.15
0.13
0.17
0.09
0.07
0.08
0.10
0.05

OCT 10

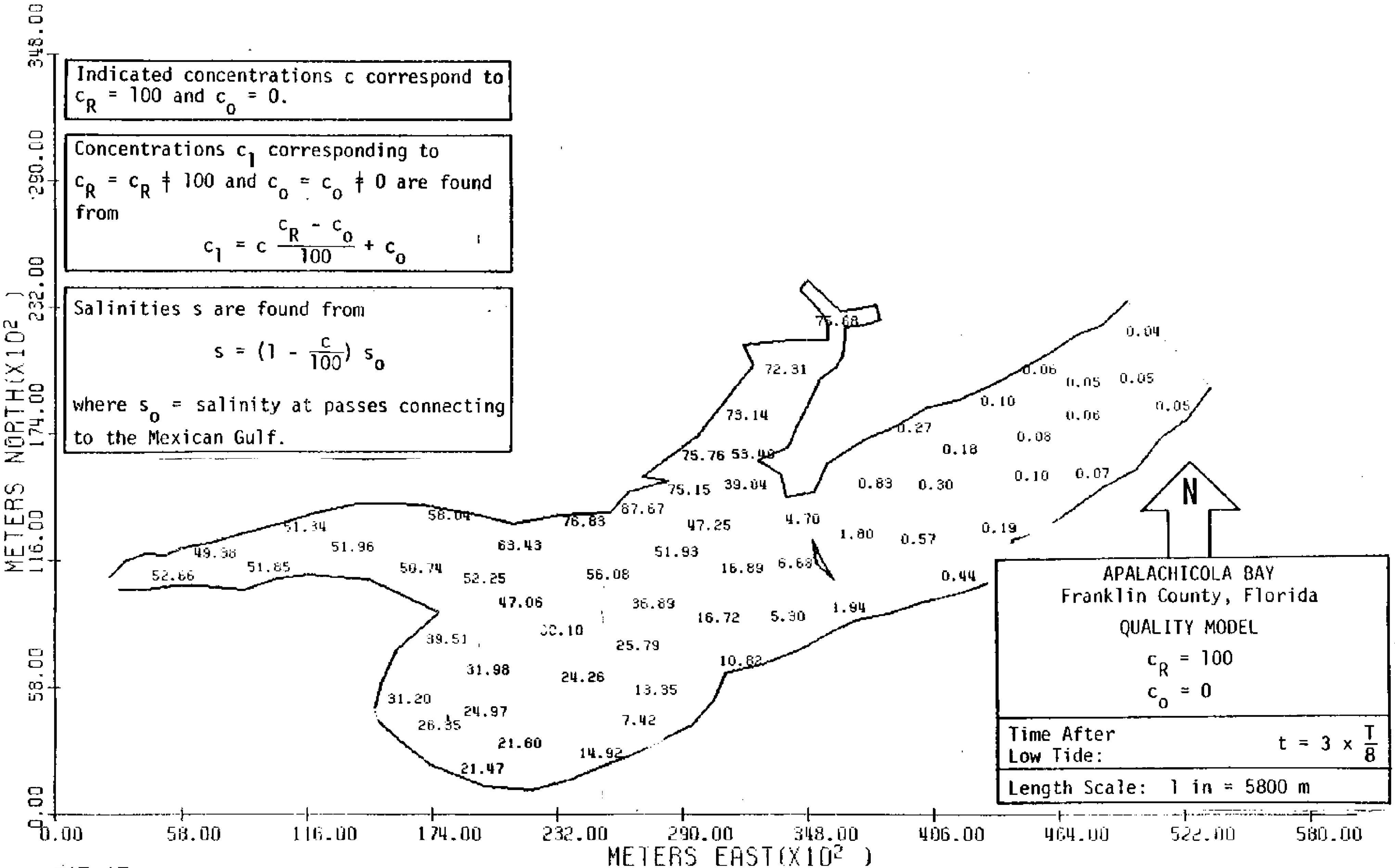

Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 1 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00

OCT 11



Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100})\, s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
N
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 2 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
METERS NORTH($\times 10^2$)
METERS EAST($\times 10^2$)

OCT 12


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c \frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = (1 - \frac{c}{100}) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide: $t = 3 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
52.66
49.38
51.85
51.34
51.96
58.04
50.74
52.25
63.43
47.06
76.83
56.08
67.67
39.51
31.98
31.20
26.35
24.97
21.60
21.47
?0.10
24.26
25.79
36.89
51.93
47.25
75.15
75.76
73.14
72.31
7?.68
53.40
39.04
4.70
16.89
6.68
16.72
5.30
13.35
7.42
14.92
10.82
1.94
1.80
0.83
0.57
0.30
0.18
0.27
0.44
0.19
0.10
0.08
0.10
0.06
0.05
0.06
0.07
0.05
0.04
0.05

OCT 13

Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.

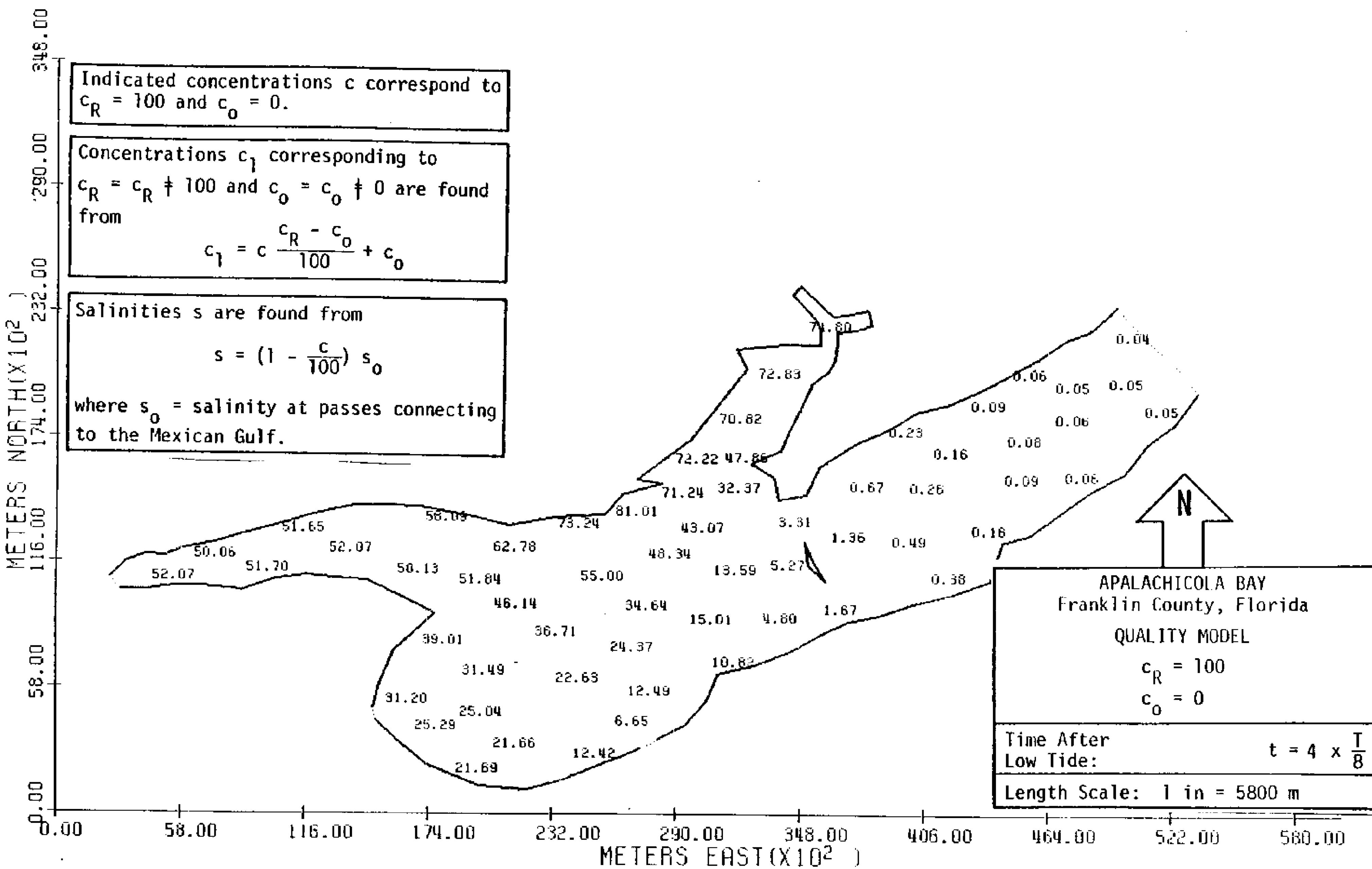
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from

$$c_1 = c \frac{c_R - c_o}{100} + c_o$$

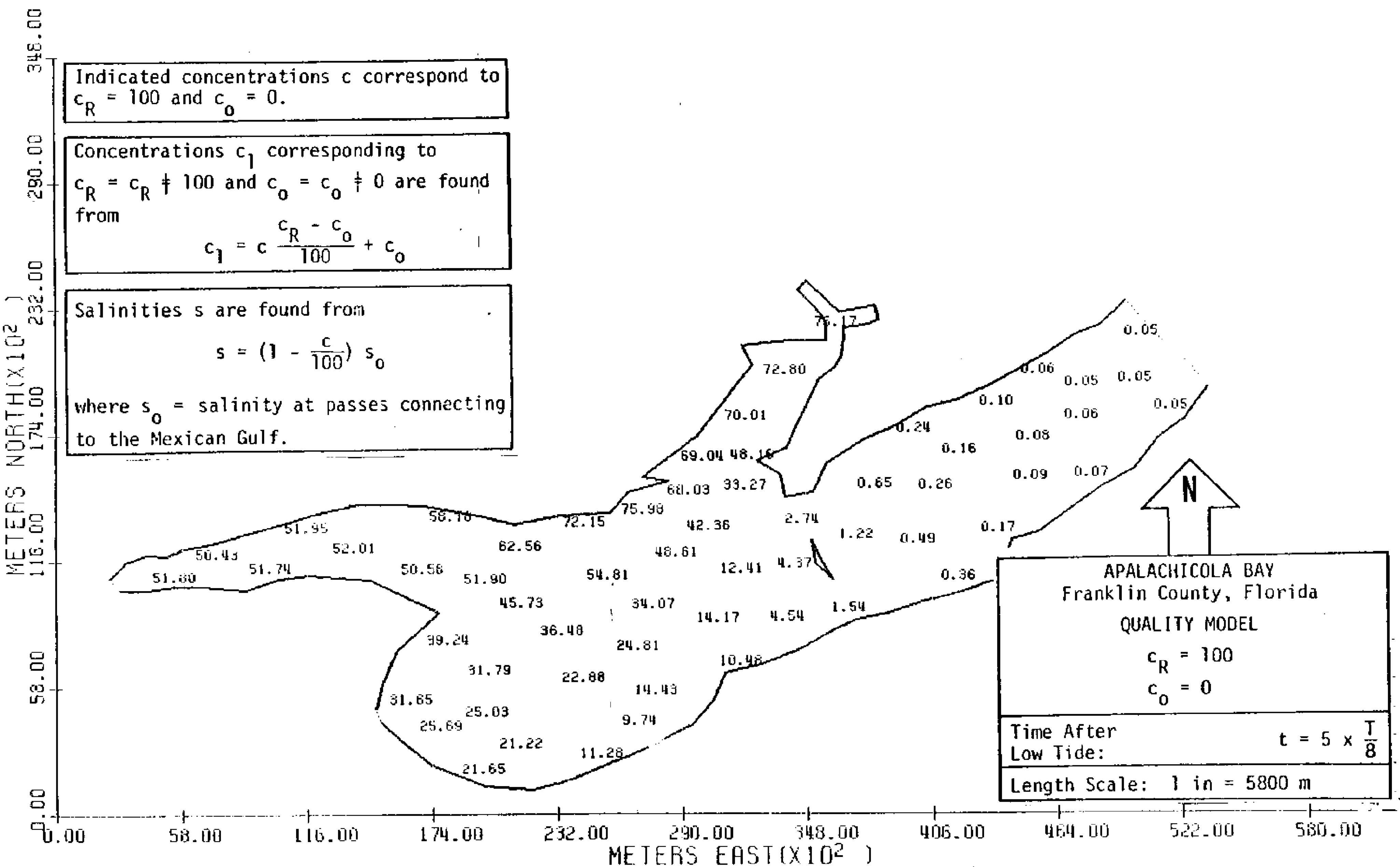
Salinities s are found from

$$s = (1 - \frac{c}{100}) s_o$$

where s_o = salinity at passes connecting to the Mexican Gulf.

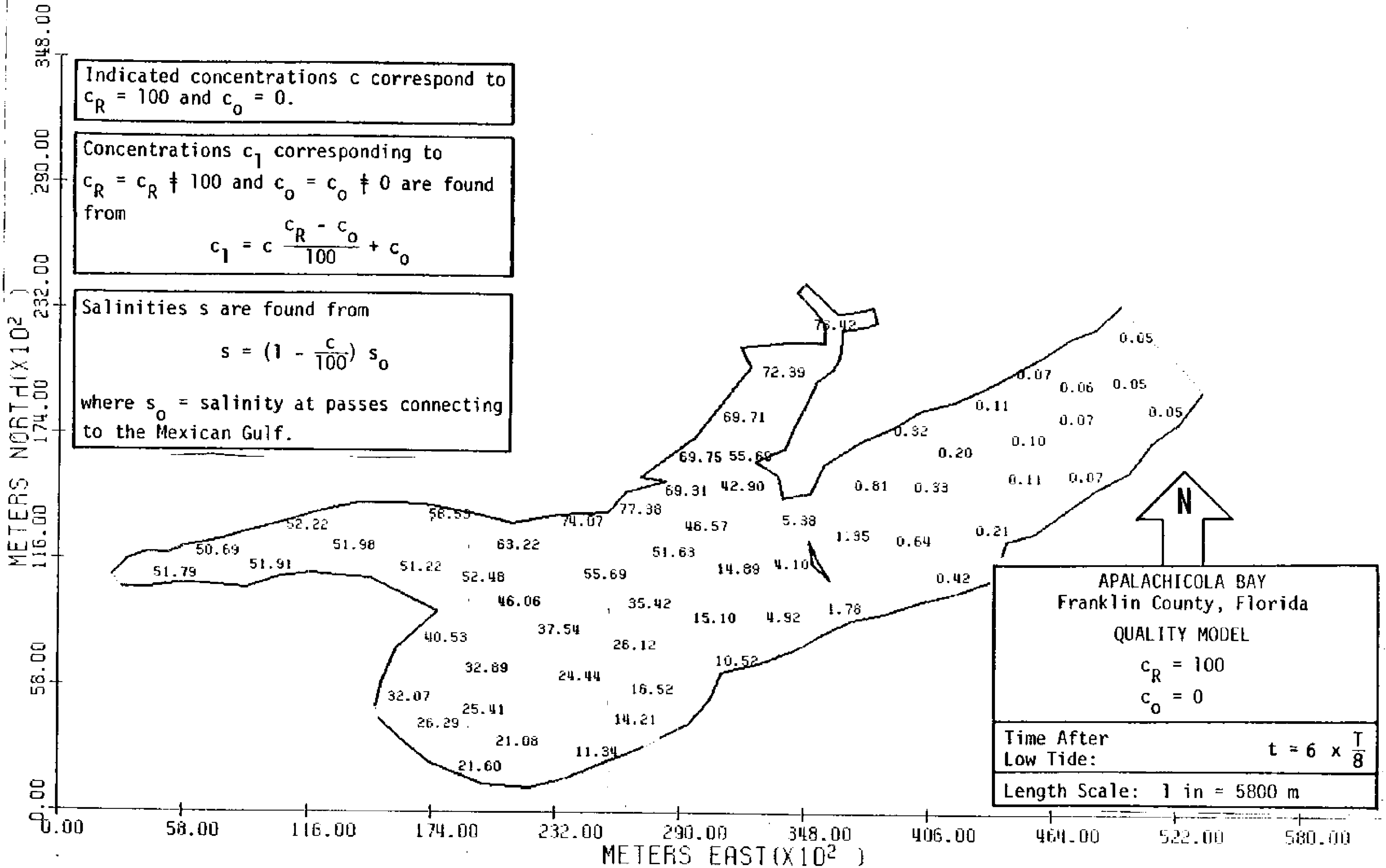


OCT 14

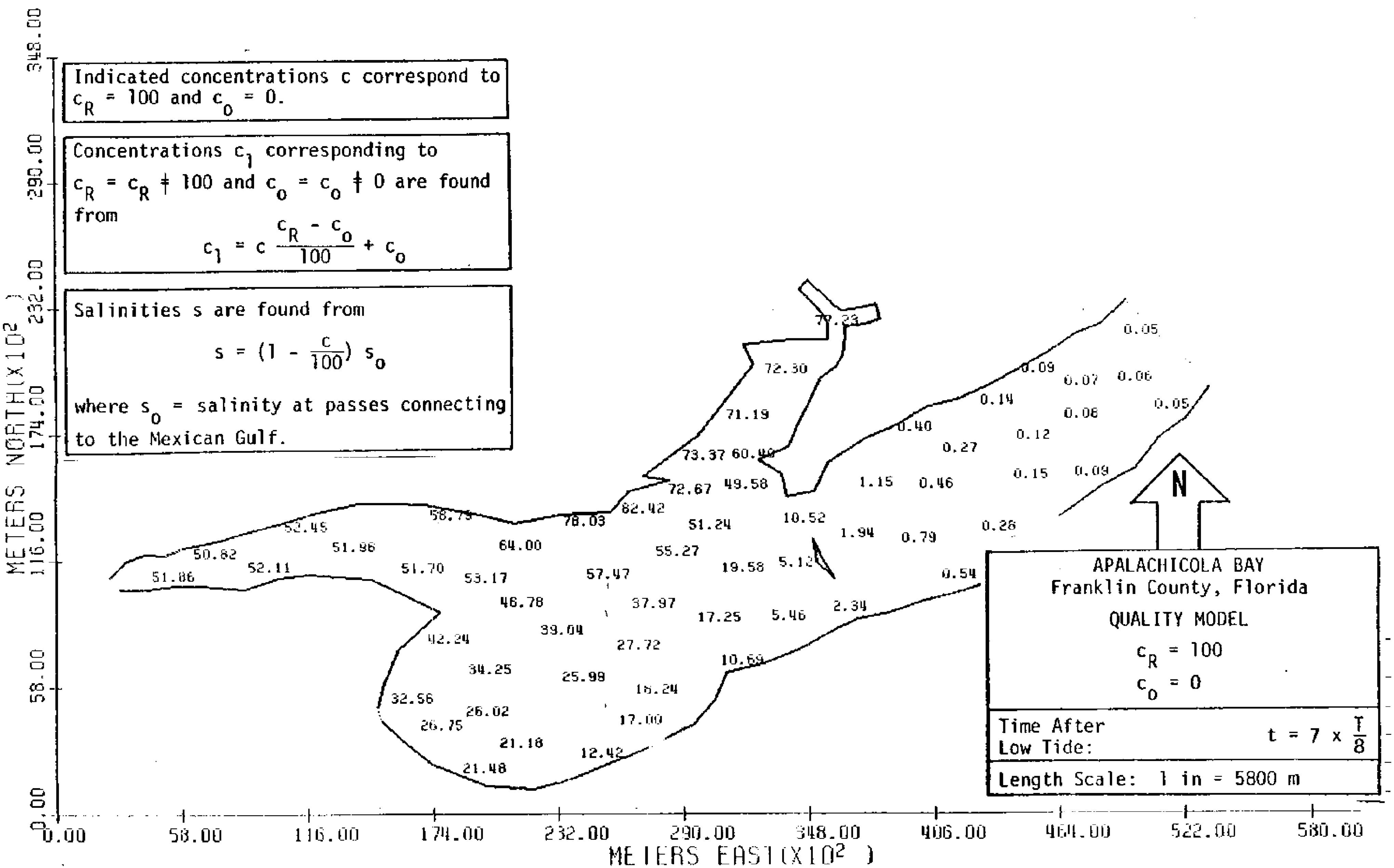


Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
N
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide:
$t = 5 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
51.80
50.43
51.95
51.74
52.01
50.56
58.10
62.56
51.90
45.73
39.24
31.79
31.65
25.69
25.03
21.22
21.65
72.15
54.81
36.48
22.88
11.28
75.98
68.03
34.07
24.81
14.43
9.74
69.04
48.16
33.27
42.36
48.61
12.41
14.17
10.48
70.01
72.80
2.74
4.37
4.54
1.54
1.22
0.65
0.49
0.36
0.24
0.16
0.26
0.17
0.10
0.08
0.09
0.07
0.06
0.05
0.06
0.05
0.05
0.05

OCT 15


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c\,\frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = \left(1 - \frac{c}{100}\right) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 6 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
51.79
50.69
51.91
52.22
51.98
51.22
58.53
63.22
52.48
46.06
40.53
32.89
32.07
25.41
26.29
21.08
21.60
37.54
24.44
11.34
74.07
55.69
77.38
35.42
26.12
16.52
14.21
69.31
69.75
55.69
69.71
72.39
76.42
42.90
46.57
51.63
14.89
15.10
10.52
4.92
4.10
5.38
1.35
1.78
0.81
0.33
0.64
0.42
0.32
0.20
0.21
0.11
0.10
0.11
0.07
0.06
0.07
0.07
0.05
0.05
0.05

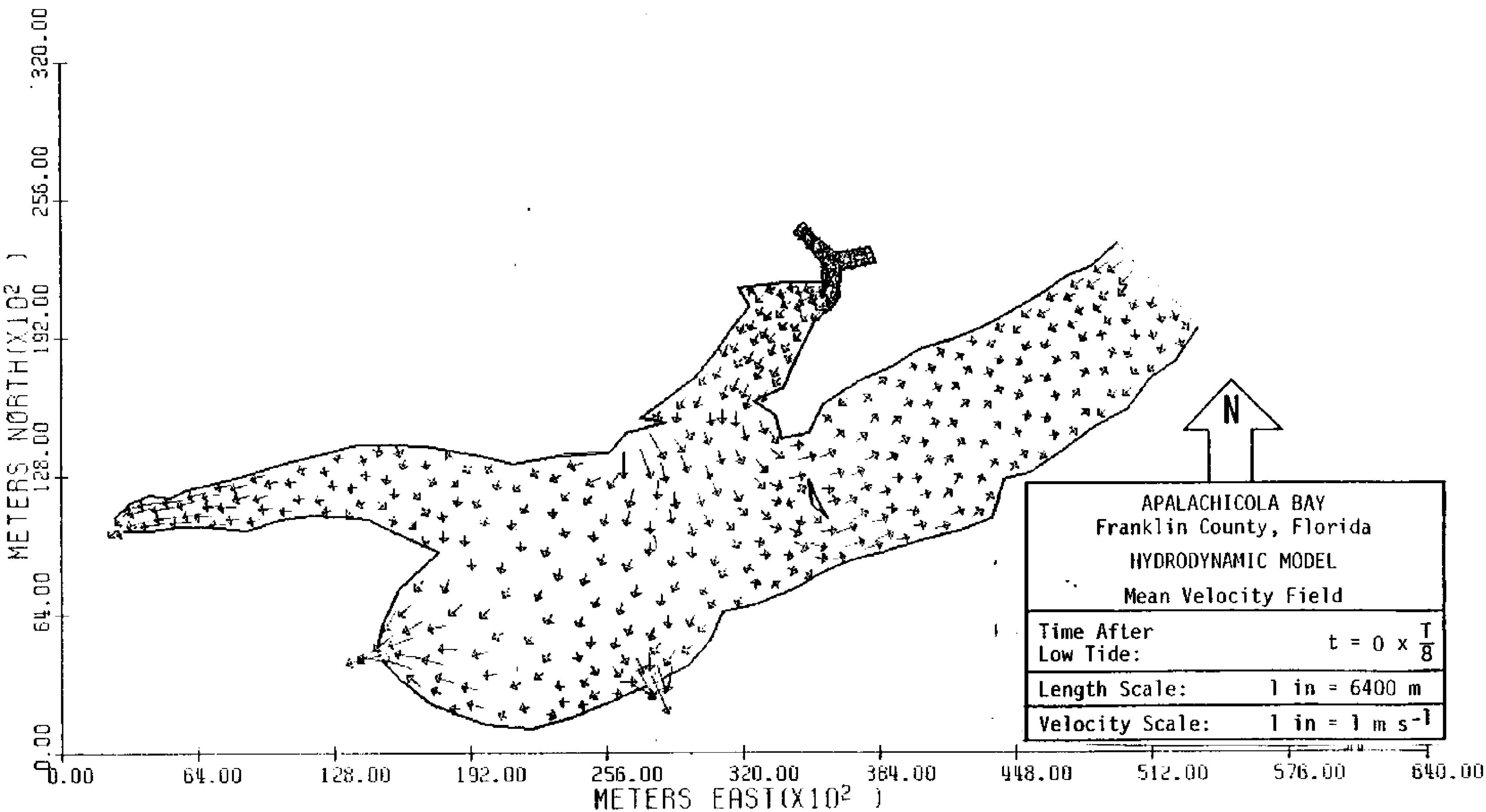
OCT 16


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 7 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
[illegible]
72.30
71.19
73.37 60.[illegible]
72.67 49.58
82.42
78.03
58.7[illegible]
52.45
50.82
51.86
52.11
51.96
51.70
53.17
64.00
46.78
57.47
55.27
51.24
42.24
39.04
37.97
34.25
32.56
26.75
26.02
25.98
27.72
21.18
21.48
12.42
17.00
16.24
17.25
19.58
10.52
10.69
5.46
5.12
2.34
1.94
1.15
0.79
0.54
0.46
0.40
0.27
0.26
0.15
0.14
0.12
0.09
0.08
0.07
0.06
0.05
0.09
0.05

OCT 17

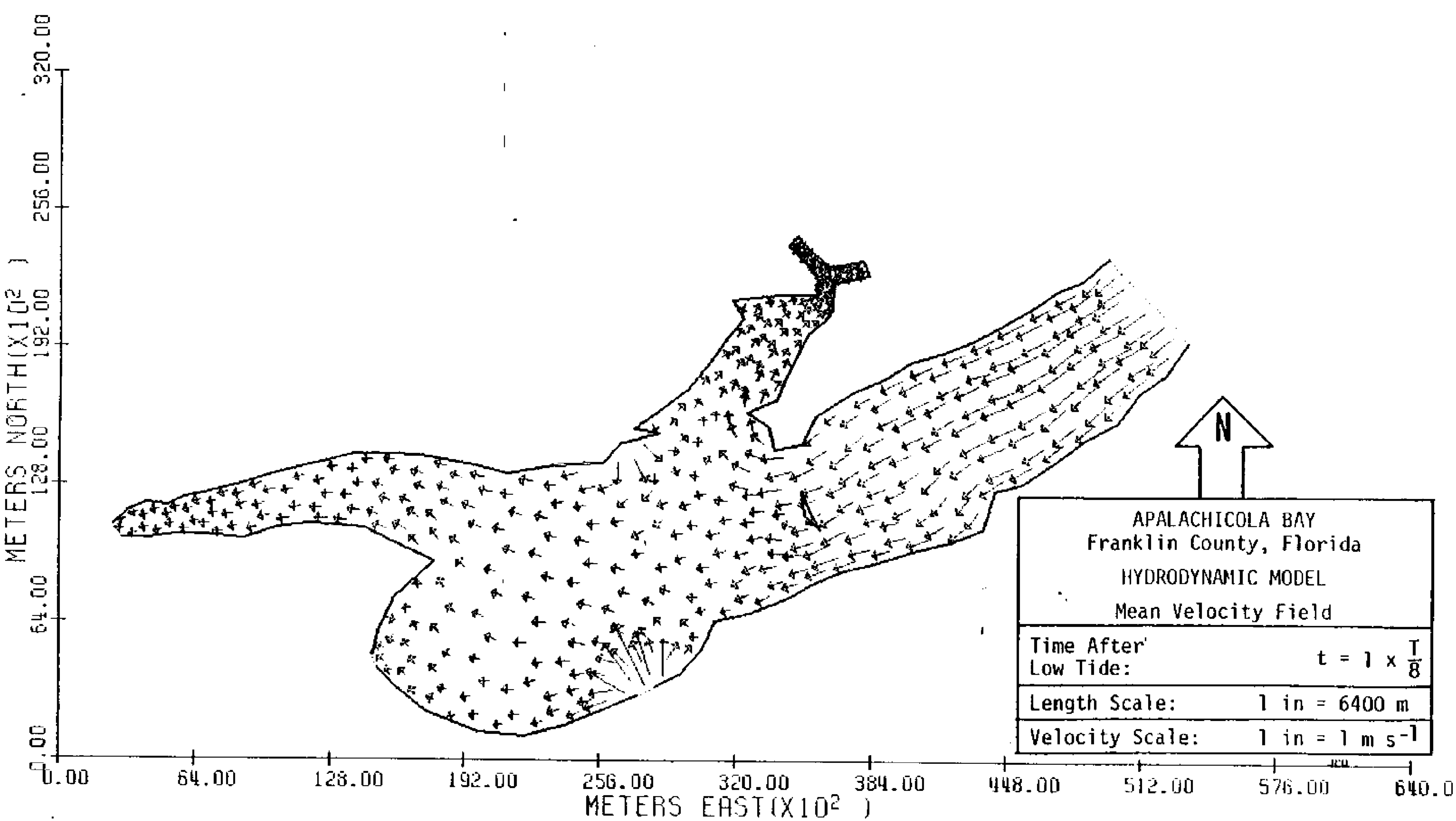
NOVEMBER

NOV 1 through NOV 8:	Vertically averaged velocities v_m given at time increments equal to one eighth of the tidal period beginning at low tide.
NOV 9:	Net values of vertically averaged velocities. Time averaged over one tidal cycle.
NOV 10 through NOV 17:	Vertically averaged pollutant concentration corresponding to river concentration $c_R = 100$ and concentration $c_o = 0$ at all inlets to bay. Concentrations given at time increments equal to one eighth of the tidal period beginning at low tide.



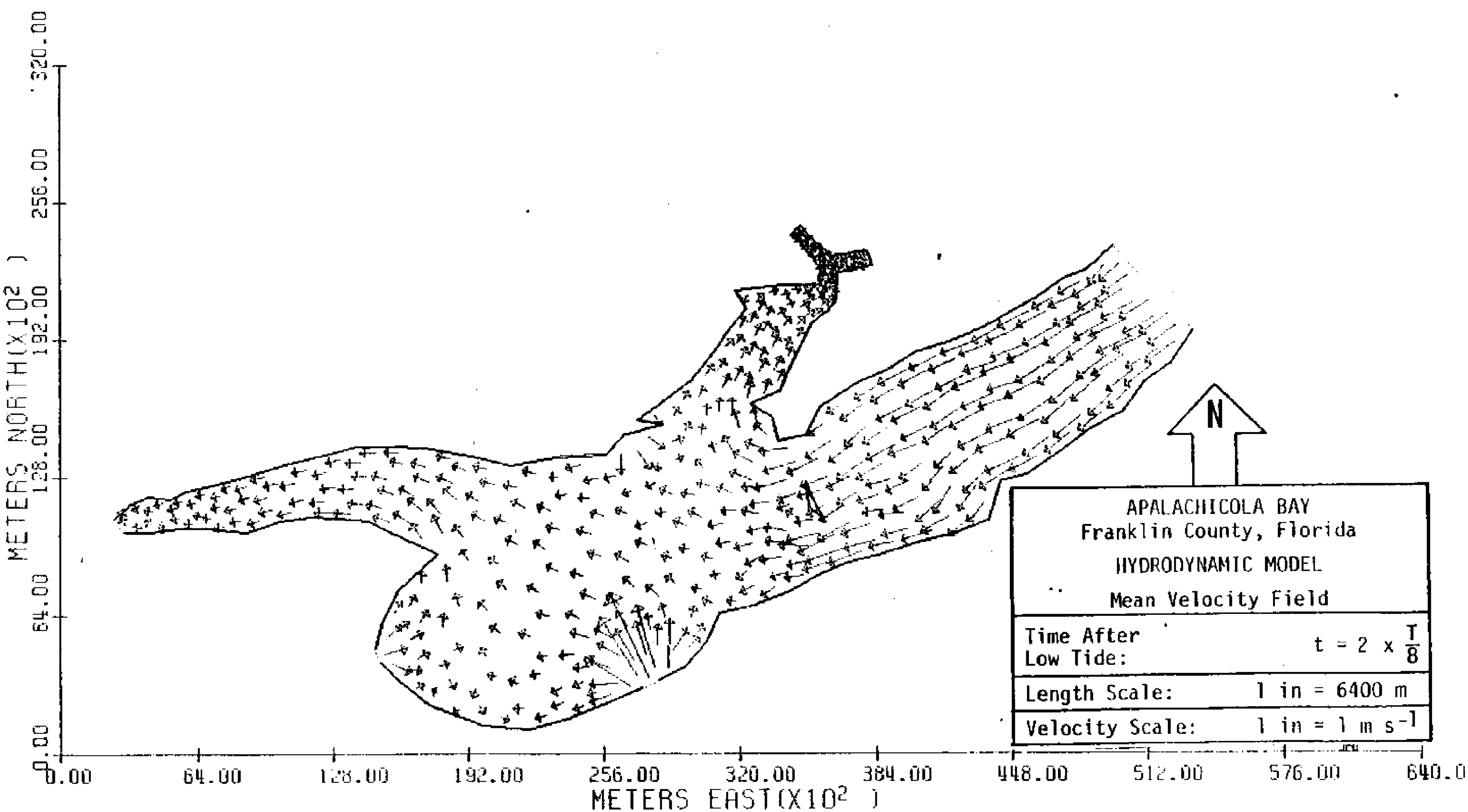
APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 0 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

NOV 1



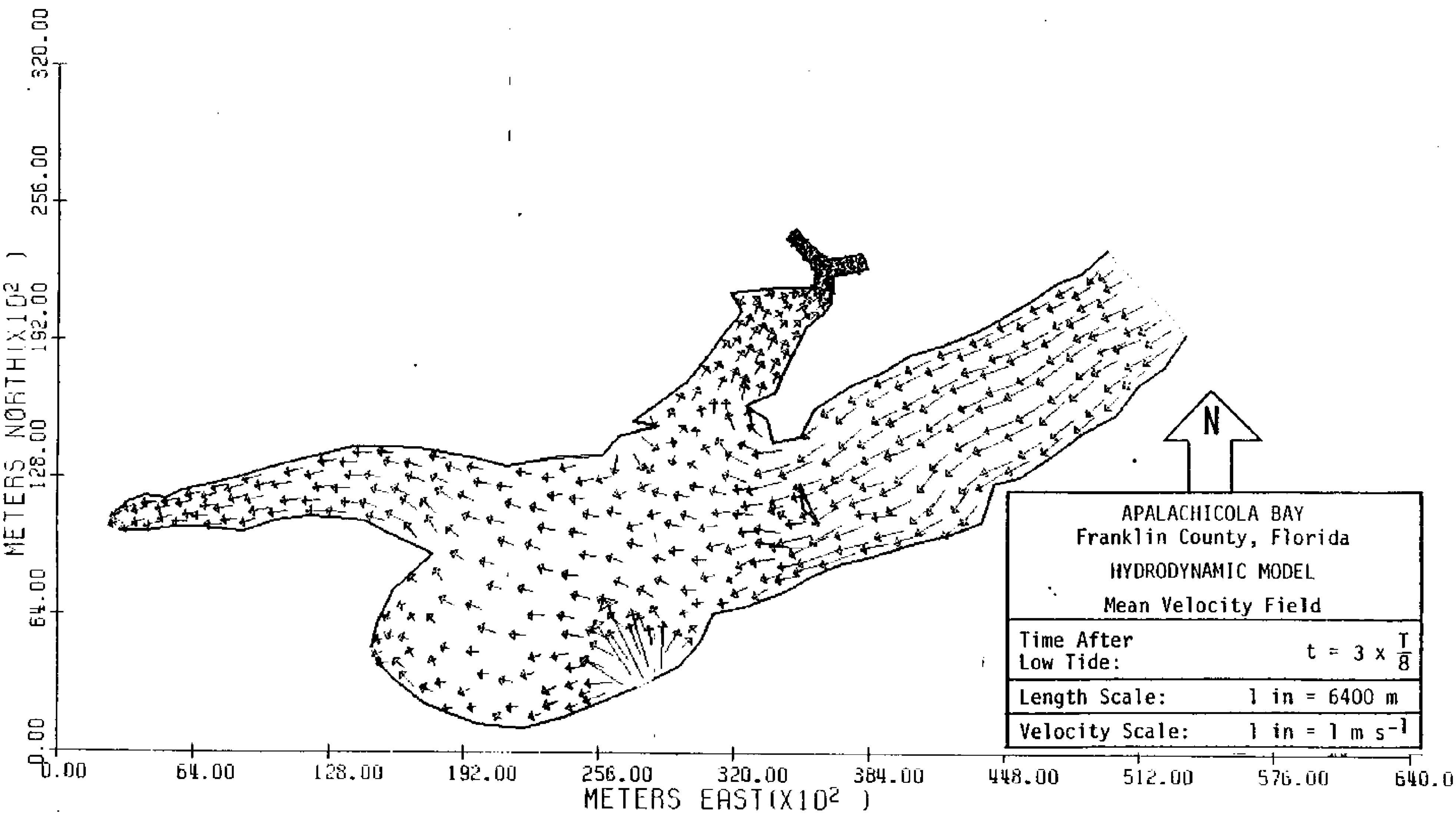
APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 1 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

NOV 2



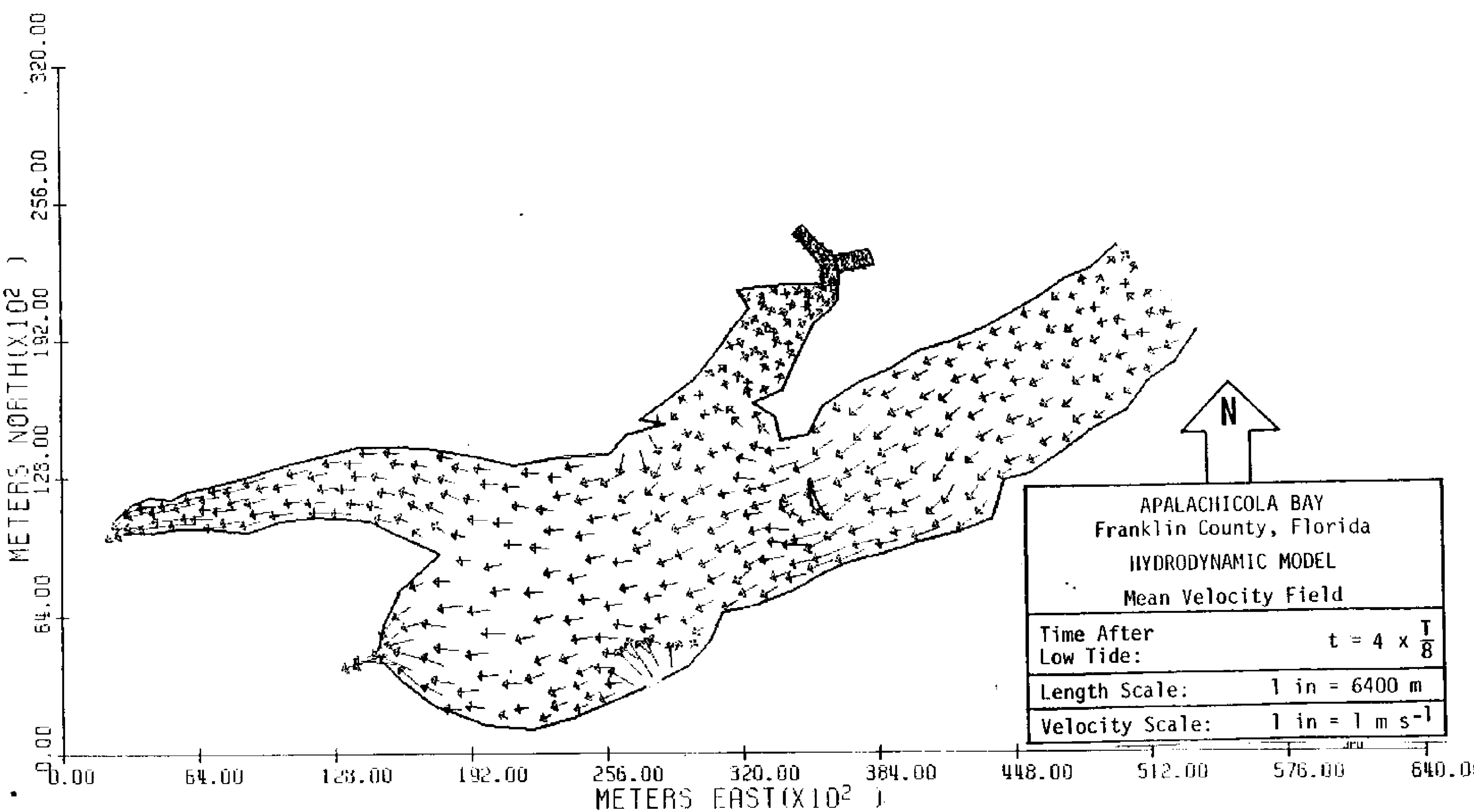
N
APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 2 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
METERS NORTH(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

NOV 3



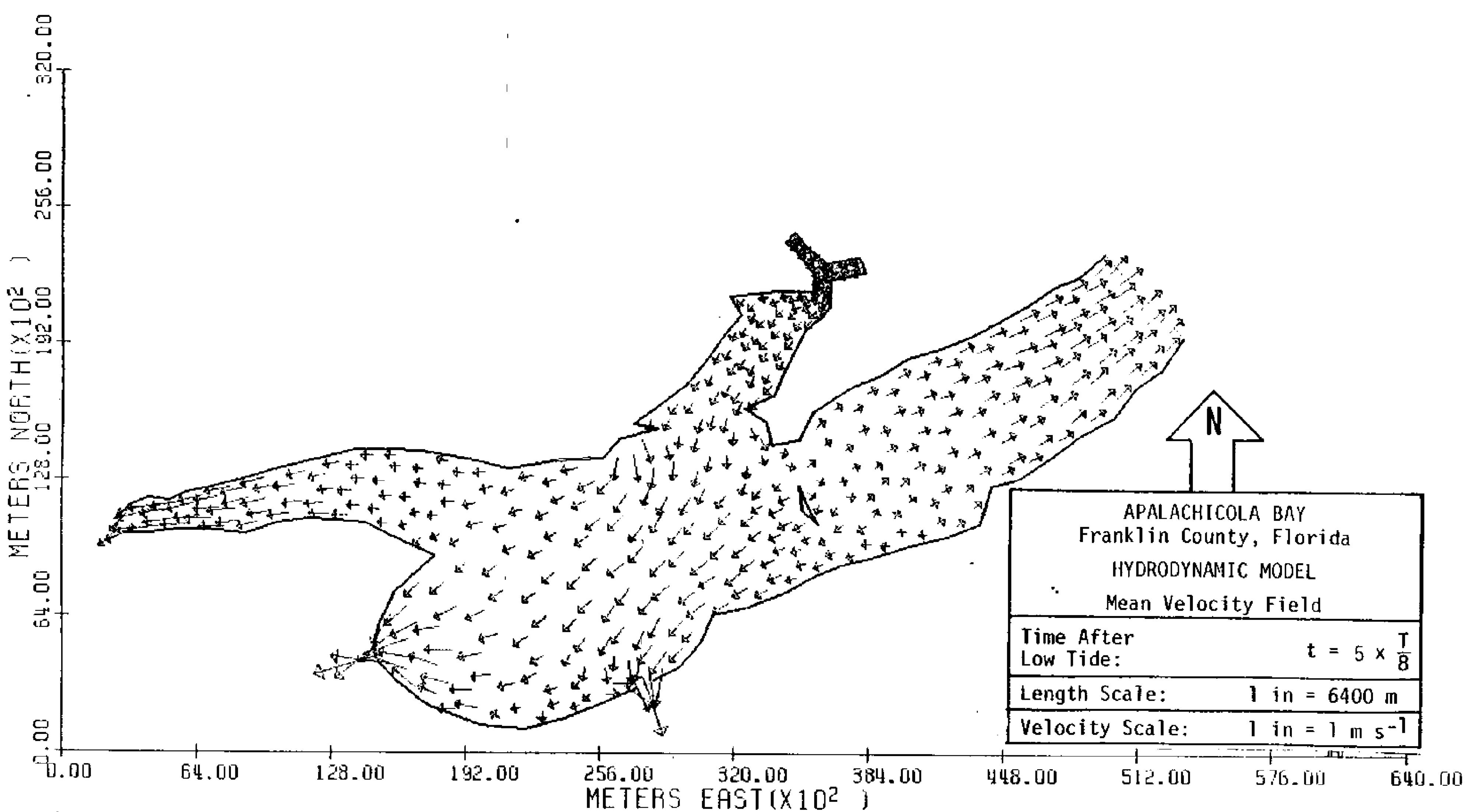
APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 3 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^-1
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

NOV 4

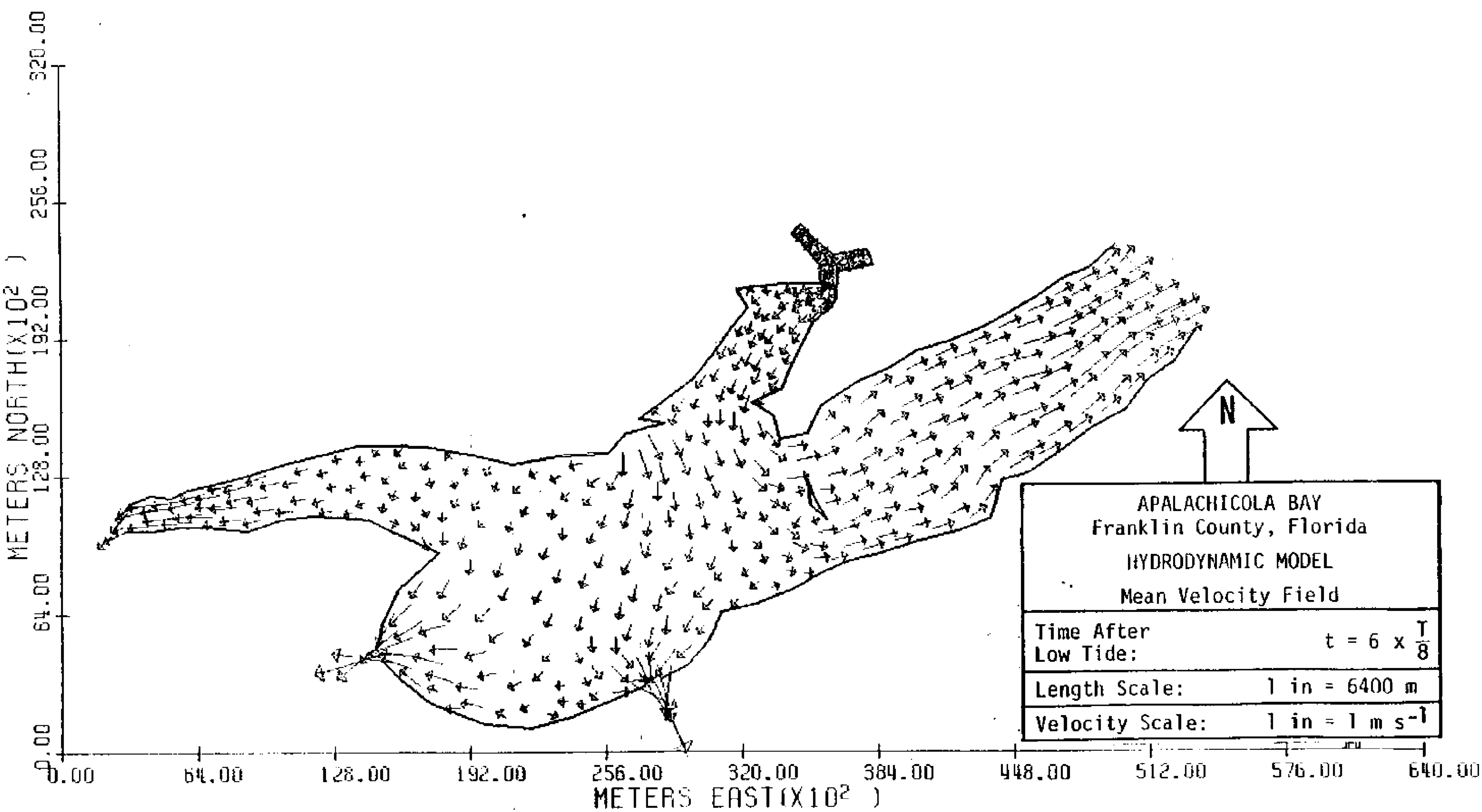


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 4 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

NOV 5

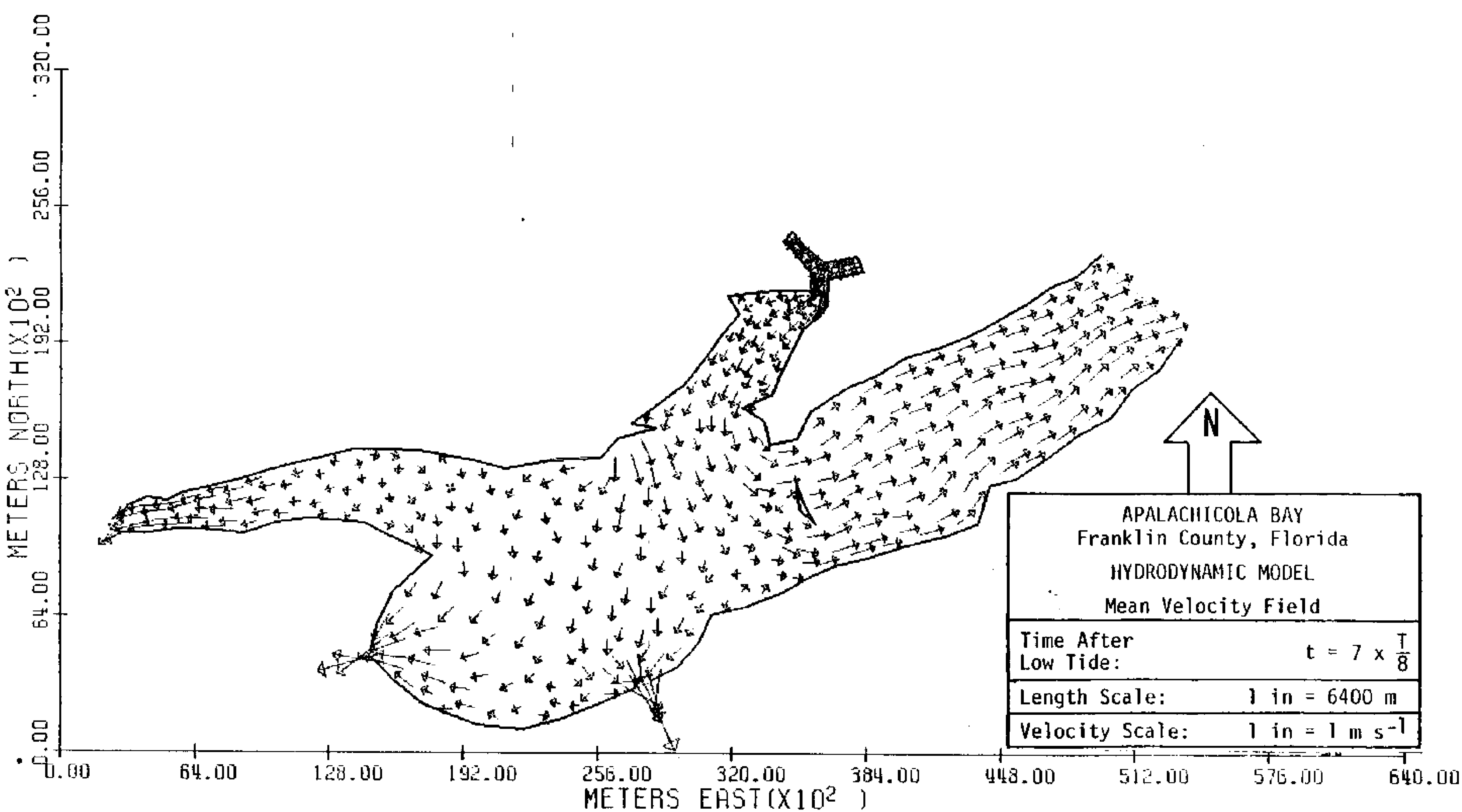

APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide:
t = 5 x T/8
Length Scale:
1 in = 6400 m
Velocity Scale:
1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

NOV 6

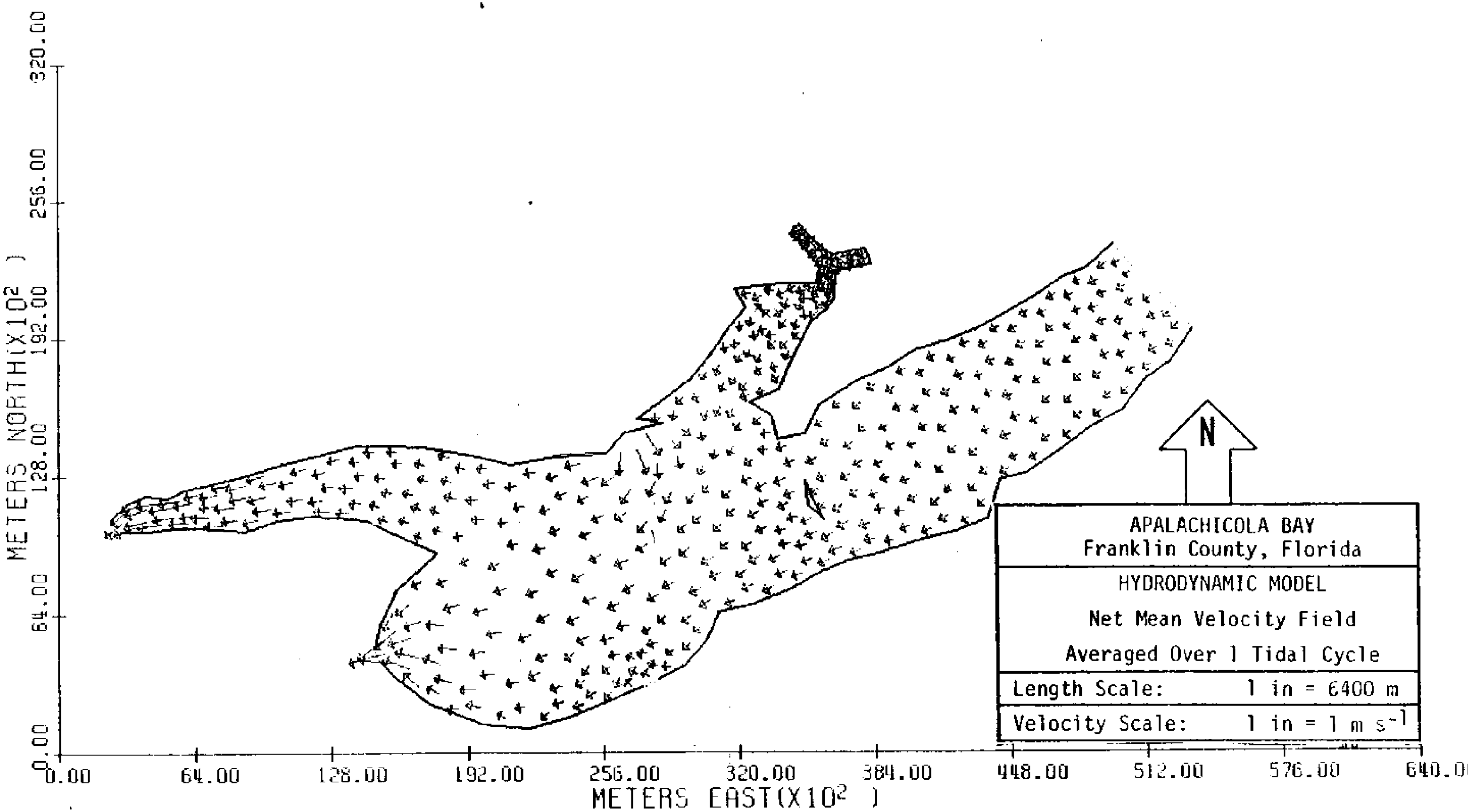


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 6 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

NOV 7

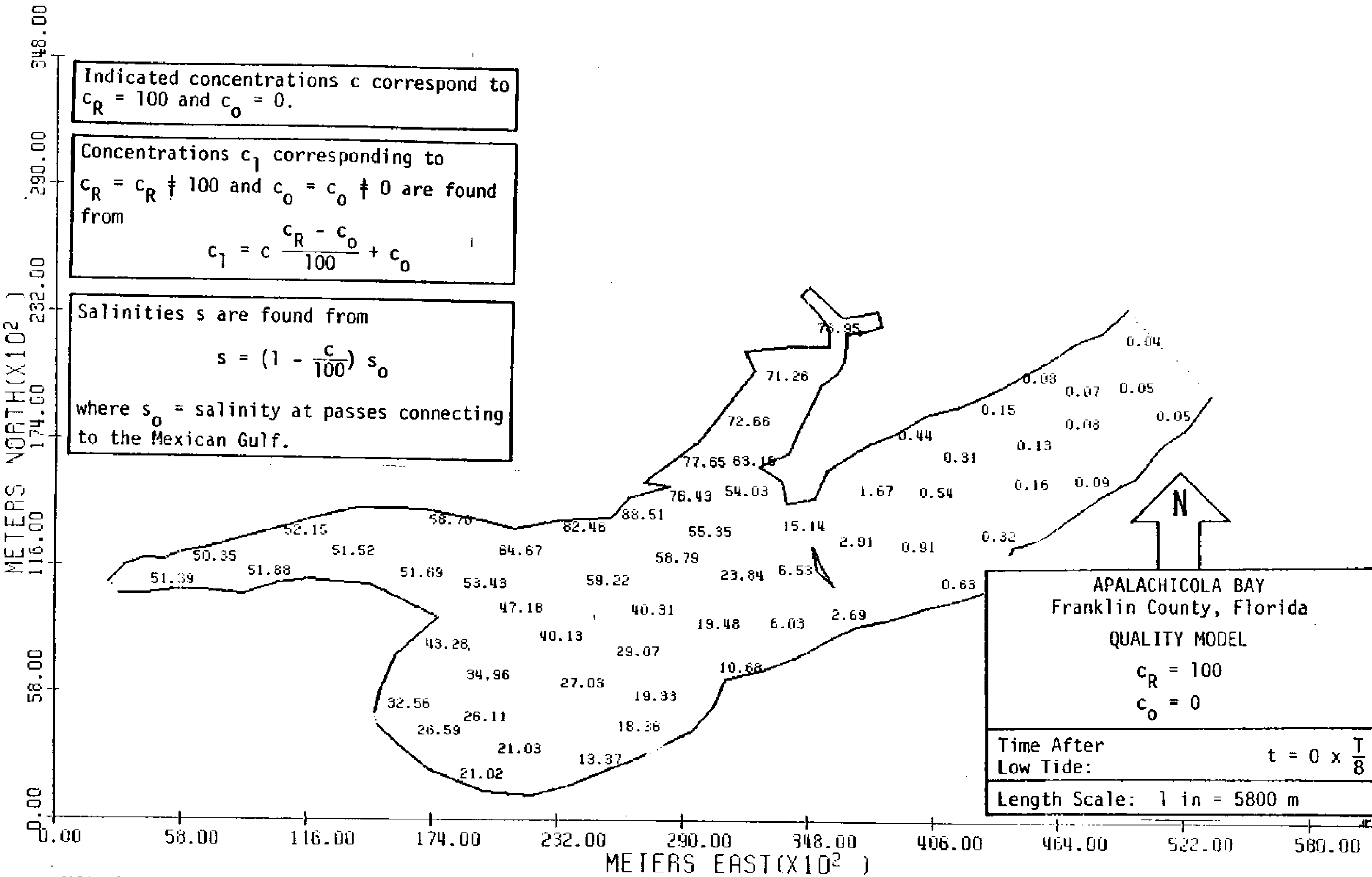

APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 7 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

NOV 8

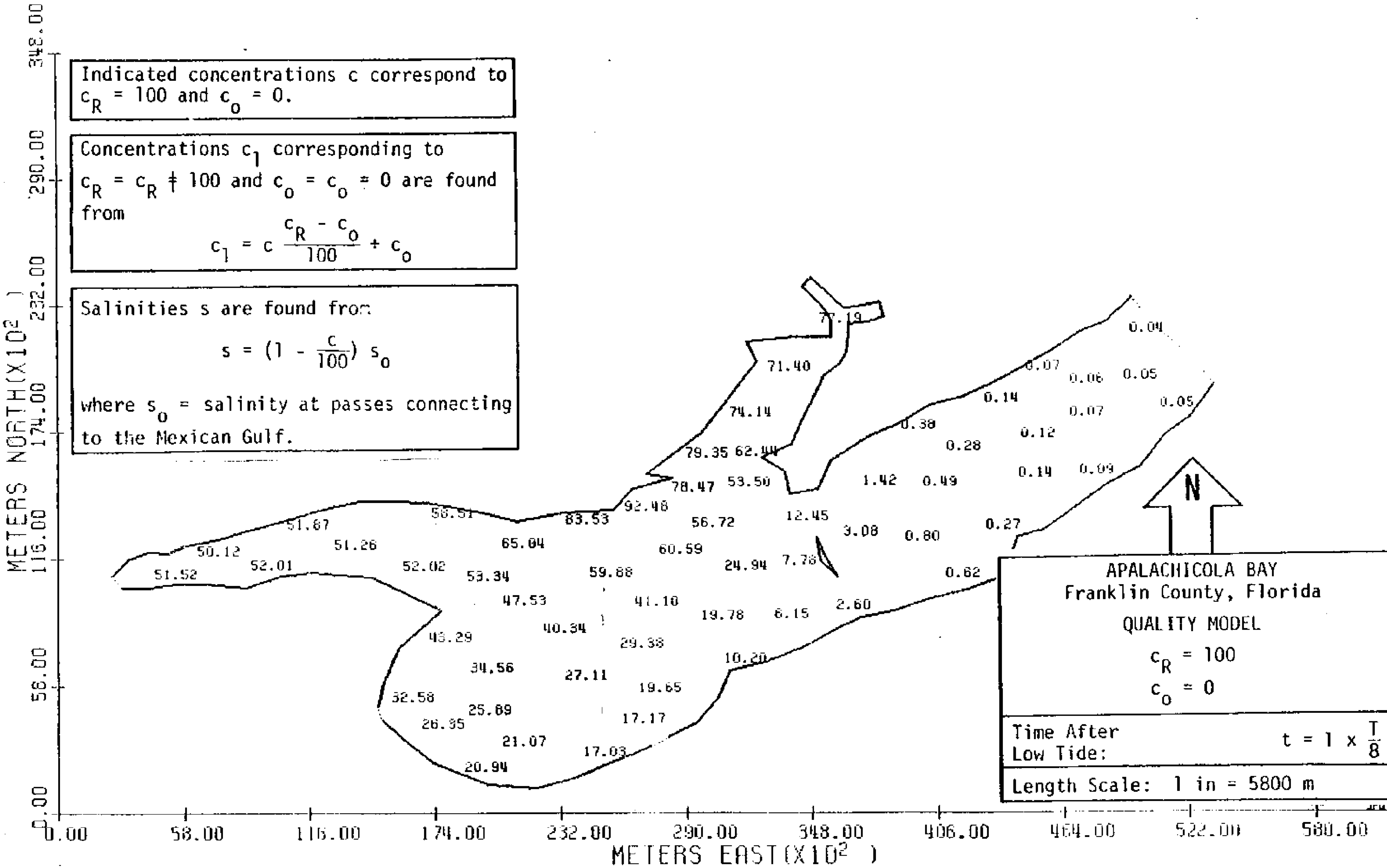


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Net Mean Velocity Field
Averaged Over 1 Tidal Cycle
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^-1
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

NOV 9

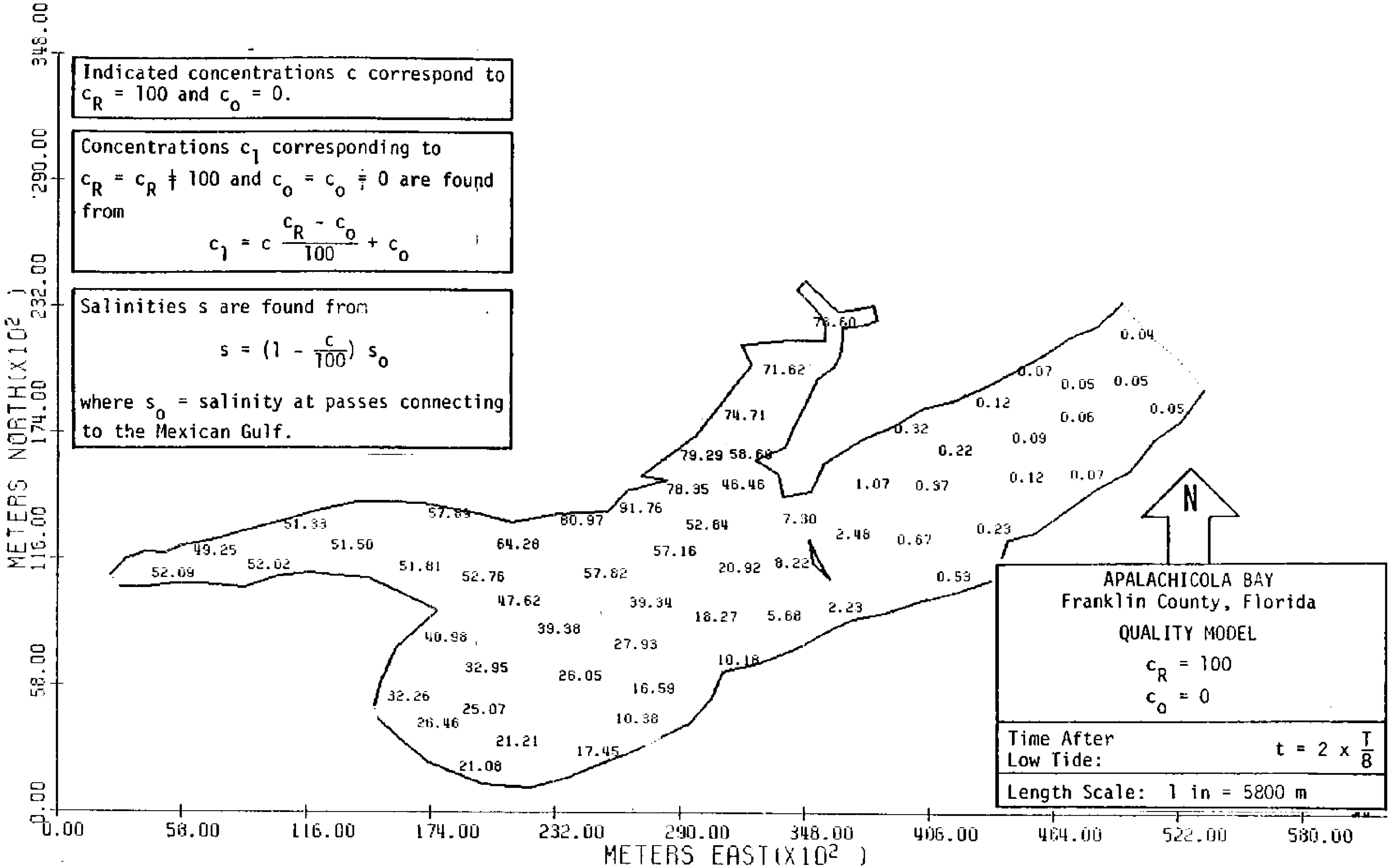

Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100})\, s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide:
$t = 0 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00

NOV 10

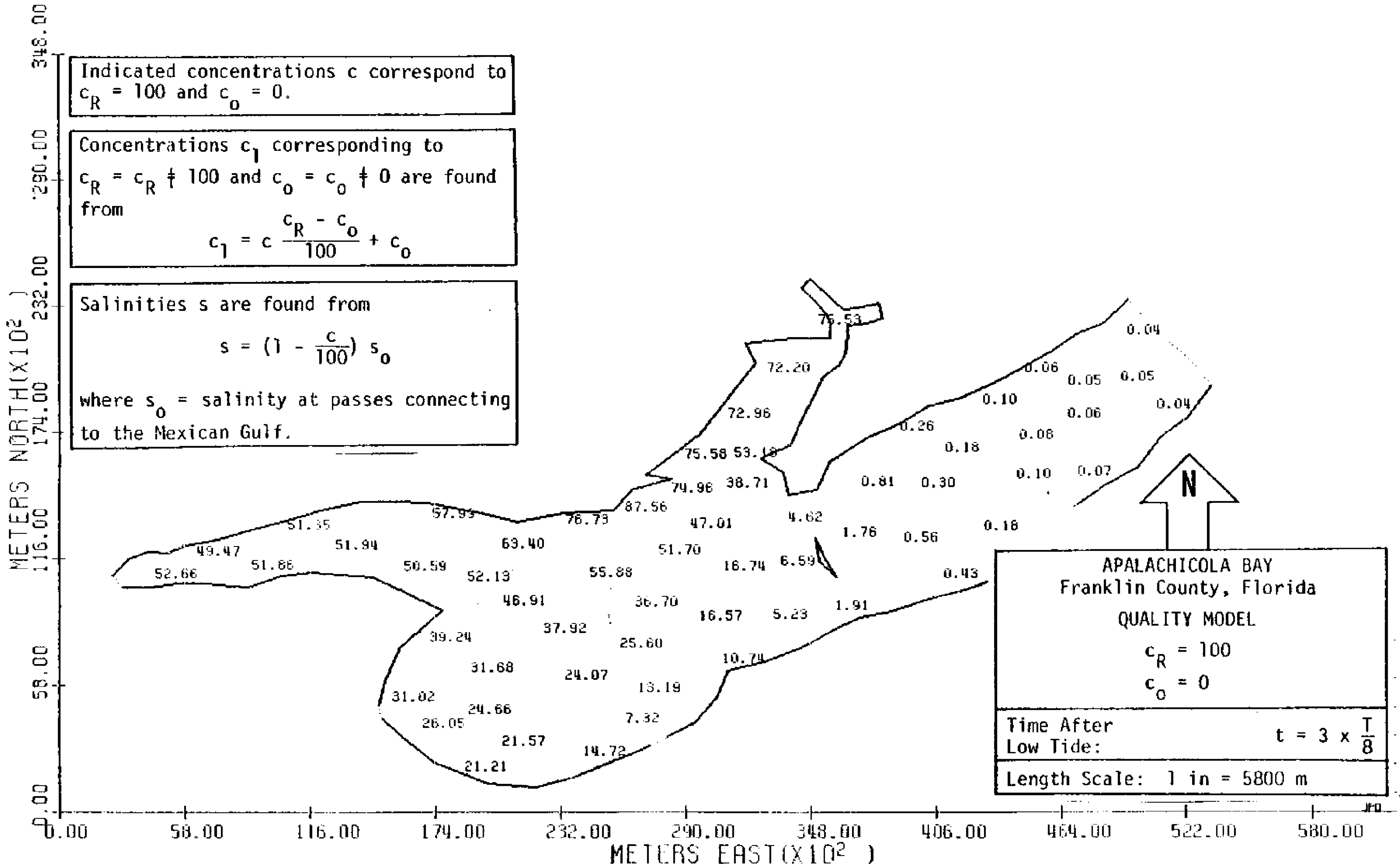


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c \frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = (1 - \frac{c}{100})\, s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 1 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
7?.19
71.40
74.14
79.35
62.44
78.47
53.50
92.48
83.53
58.51
51.67
50.12
51.52
52.01
51.26
52.02
65.04
53.34
47.53
43.29
34.56
32.58
26.35
25.89
21.07
20.94
40.34
27.11
59.88
56.72
60.59
41.10
29.38
19.65
17.17
17.03
24.94
19.78
10.20
12.45
7.78
6.15
2.60
3.08
1.42
0.80
0.49
0.38
0.28
0.14
0.12
0.14
0.09
0.07
0.07
0.06
0.05
0.05
0.04
0.27
0.62

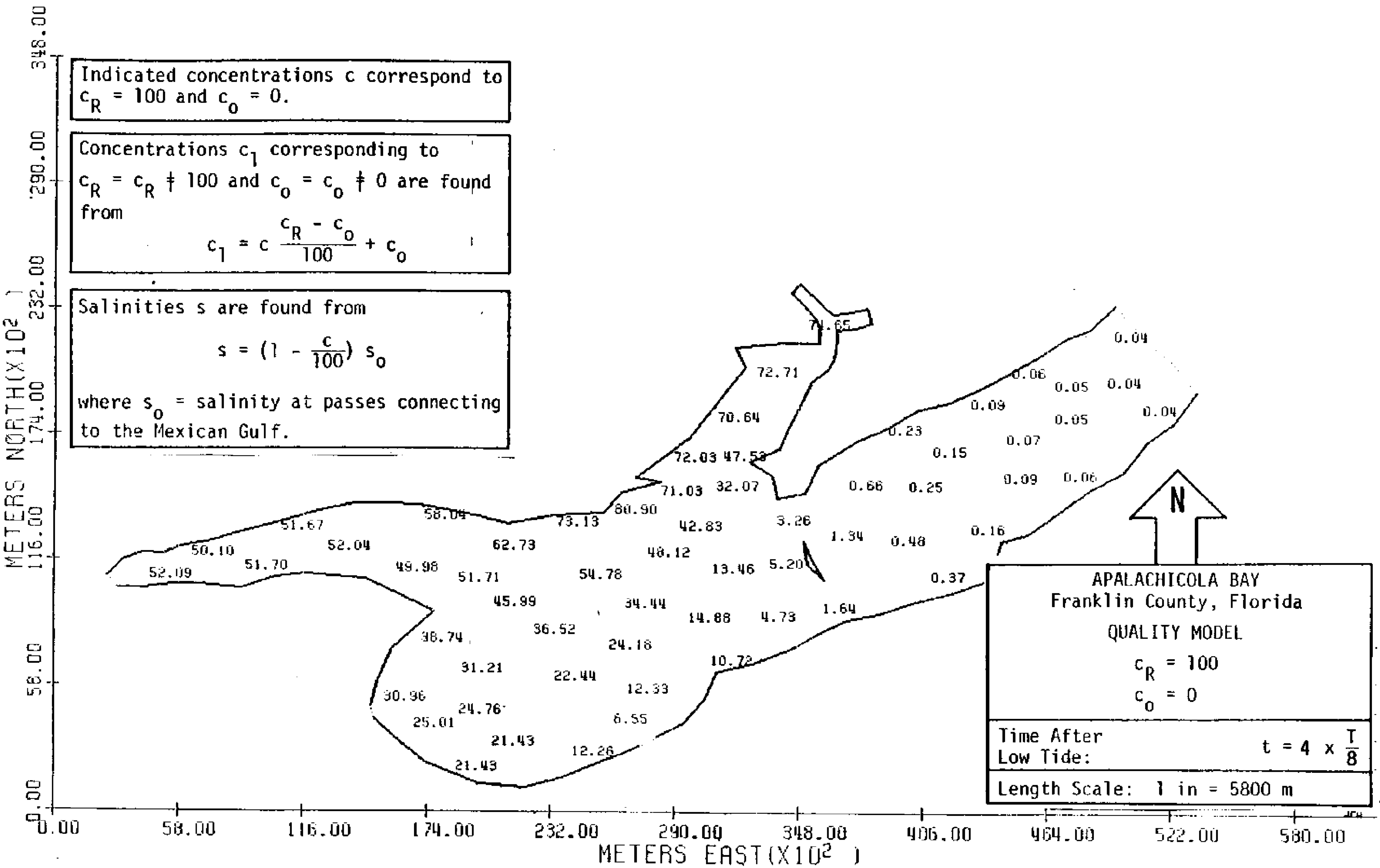
NOV 11


Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100})\, s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide:
$t = 2 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)

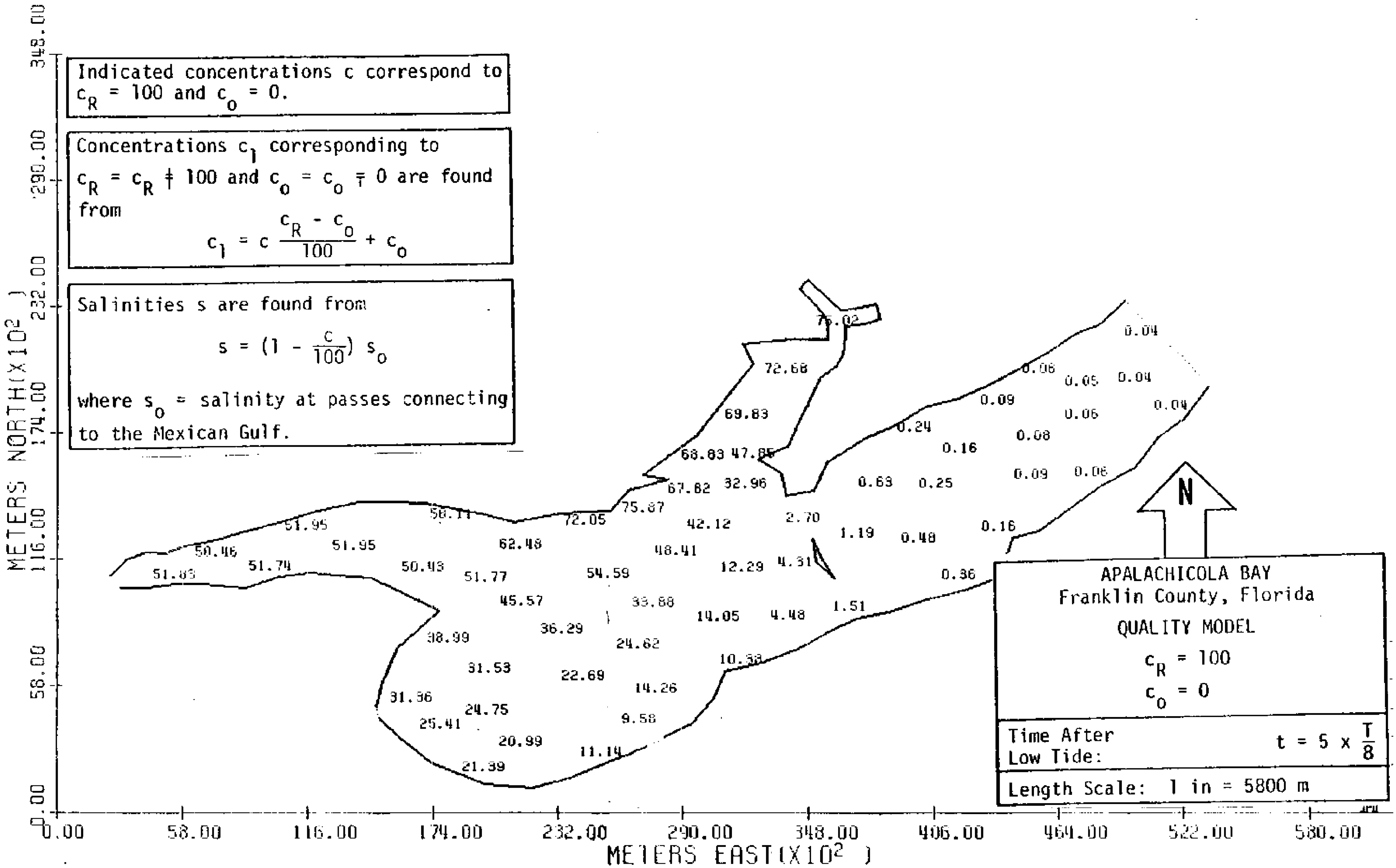
NOV 12


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c \frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = (1 - \frac{c}{100}) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide: $t = 3 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
75.53
72.20
72.96
75.58 53.18
74.98 38.71
87.56
76.73
57.93
51.35
49.47
52.66
51.86
51.94
50.59
52.13
63.40
46.91
55.88
47.01
51.70
36.70
37.92
39.24
31.68
24.07
25.60
16.74
16.57
10.74
13.19
7.32
14.72
21.57
21.21
26.05
24.66
31.02
4.62
6.59
5.23
1.91
1.76
0.81
0.30
0.56
0.43
0.18
0.26
0.18
0.10
0.06
0.08
0.10
0.05
0.06
0.07
0.04
0.05
0.04

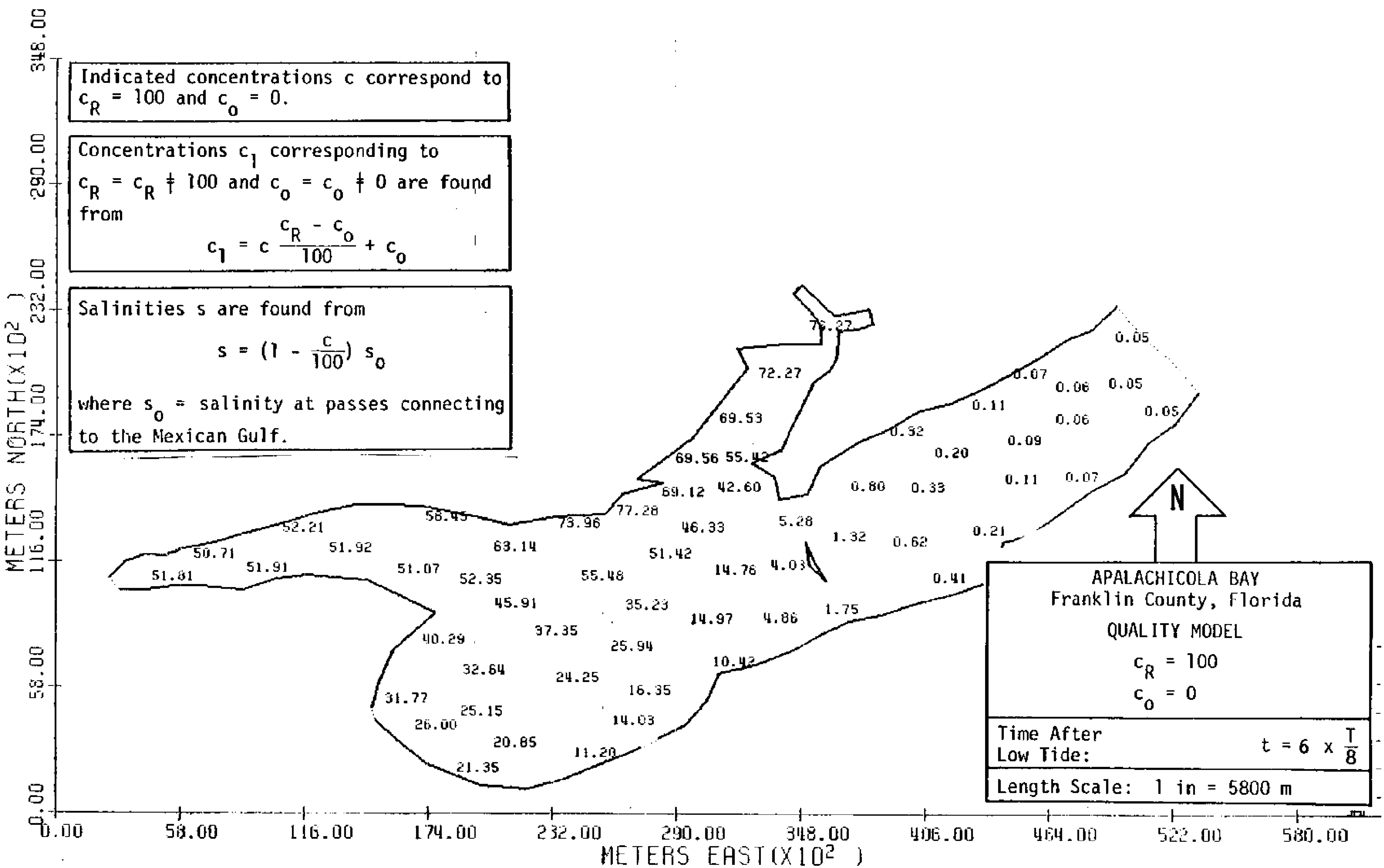
NOV 13


Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c \frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = (1 - \frac{c}{100})\, s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide:
$t = 4 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
0.04 0.06 0.05 0.04 0.09 0.05 0.04 0.23 0.07 0.15 0.66 0.25 0.09 0.06 0.16 1.34 0.48 0.37 3.26 5.20 1.64 13.46 4.73 14.88 10.72
72.71 70.64 72.03 47.53 71.03 32.07 80.90 42.83 48.12 73.13 58.04 62.73 54.78 34.44 24.18 12.33 6.55 12.26
51.67 50.10 52.09 51.70 52.04 49.98 51.71 45.99 36.52 36.74 31.21 22.44 30.96 24.76 25.01 21.43 21.43

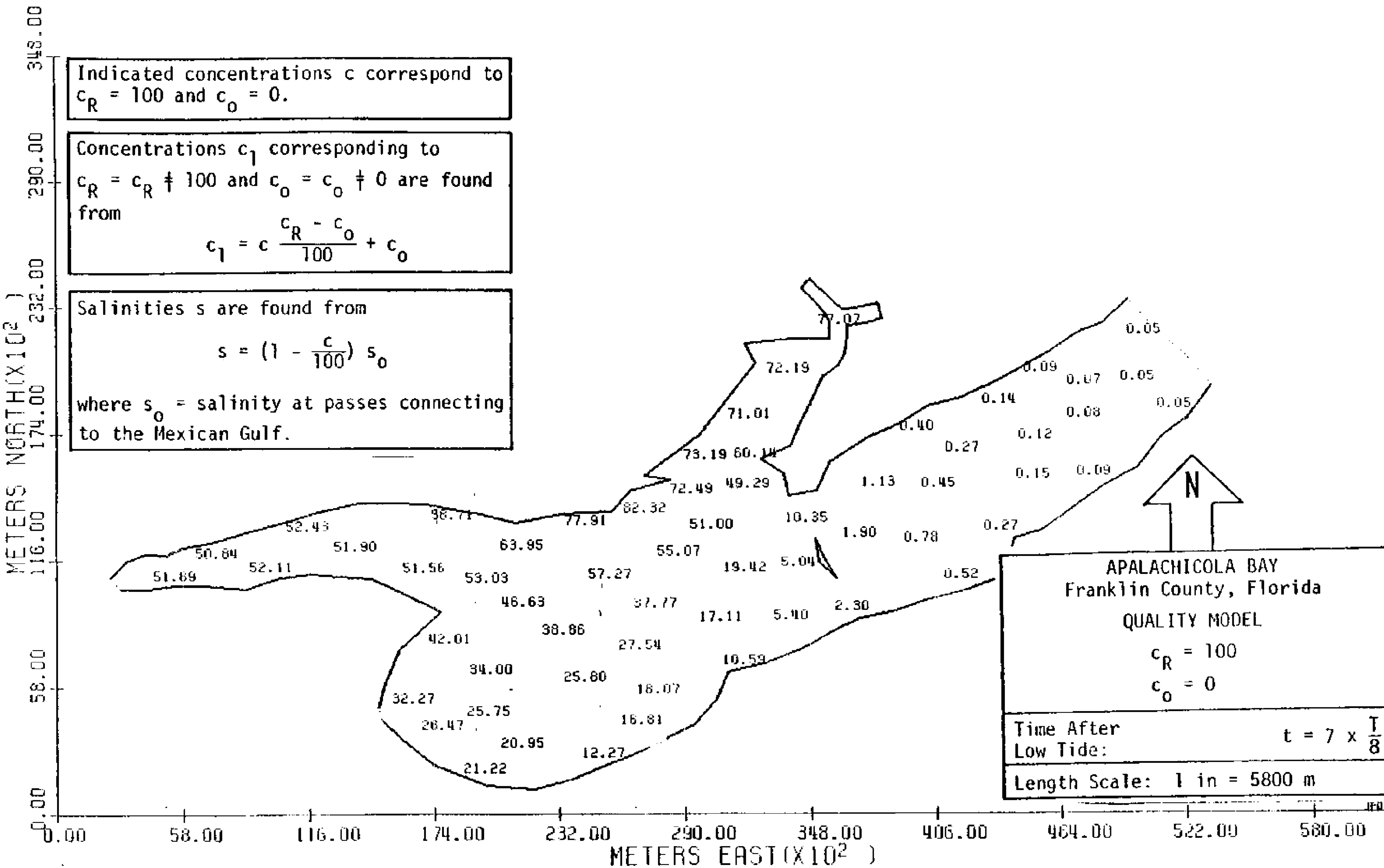
NOV 14


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 5 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
75.02
72.68
69.83
68.83
47.85
67.82
32.96
75.87
72.05
42.12
2.70
1.19
0.48
0.63
0.25
0.16
0.24
0.09
0.08
0.06
0.05
0.04
0.09
0.16
0.36
4.31
12.29
48.41
54.59
62.48
58.11
51.95
51.95
50.46
51.74
51.83
50.43
51.77
45.57
36.29
33.88
14.05
4.48
1.51
10.38
24.62
14.26
9.58
22.69
11.14
38.99
31.53
24.75
31.36
25.41
20.99
21.39

NOV 15


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c \frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = (1 - \frac{c}{100})\, s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 6 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
72.27
69.53
69.56
55.42
69.12
42.60
77.28
73.96
58.45
52.21
50.71
51.81
51.91
51.92
51.07
63.14
52.35
46.33
51.42
55.48
45.91
40.29
37.35
35.23
32.64
24.25
25.94
31.77
25.15
26.00
20.85
21.35
11.20
14.03
16.35
10.42
14.97
4.86
14.76
4.03
5.28
1.32
1.75
0.80
0.33
0.62
0.41
0.32
0.20
0.11
0.09
0.21
0.07
0.06
0.05

NOV 16

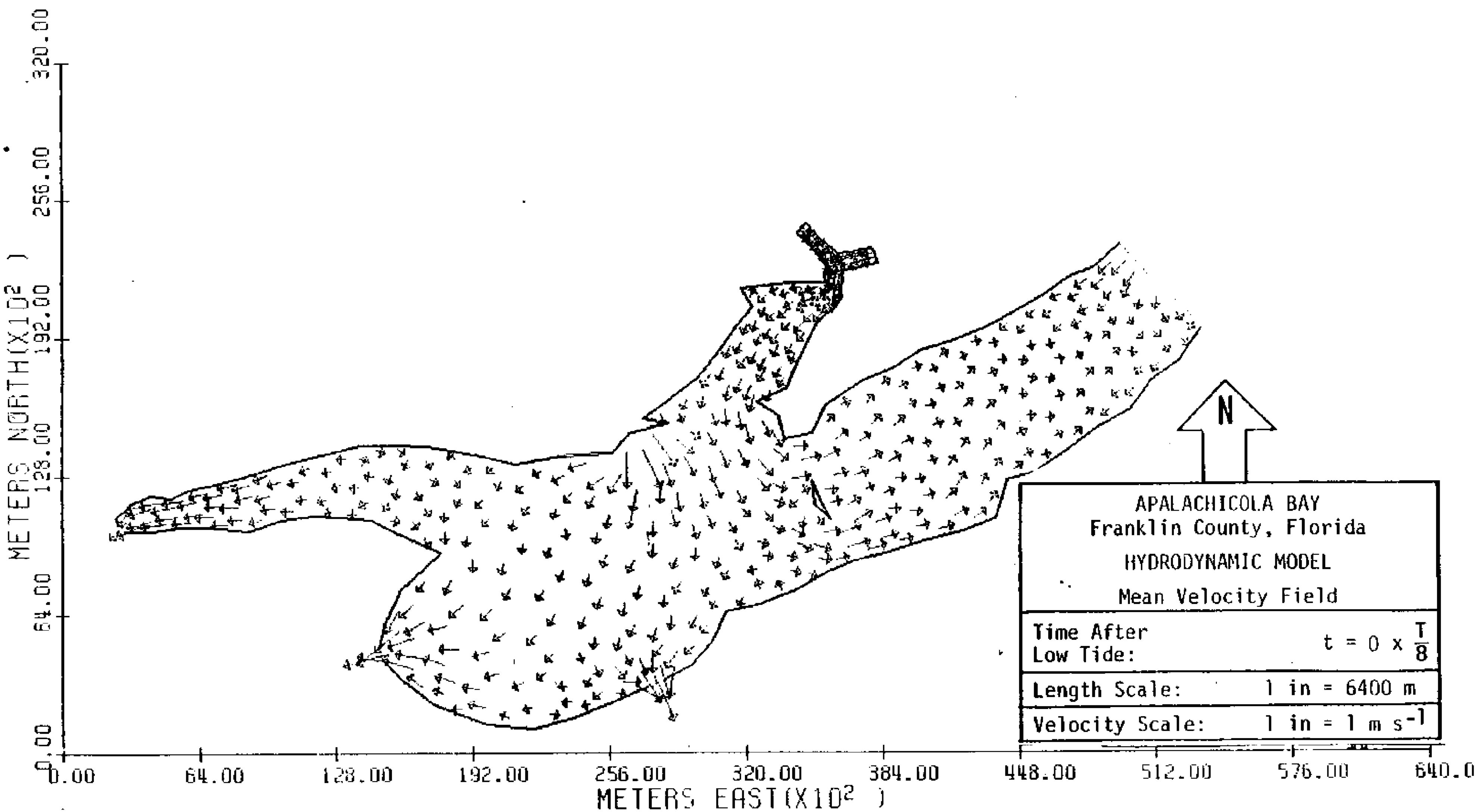


Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100})\, s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
N
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide:
$t = 7 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00

NOV 17

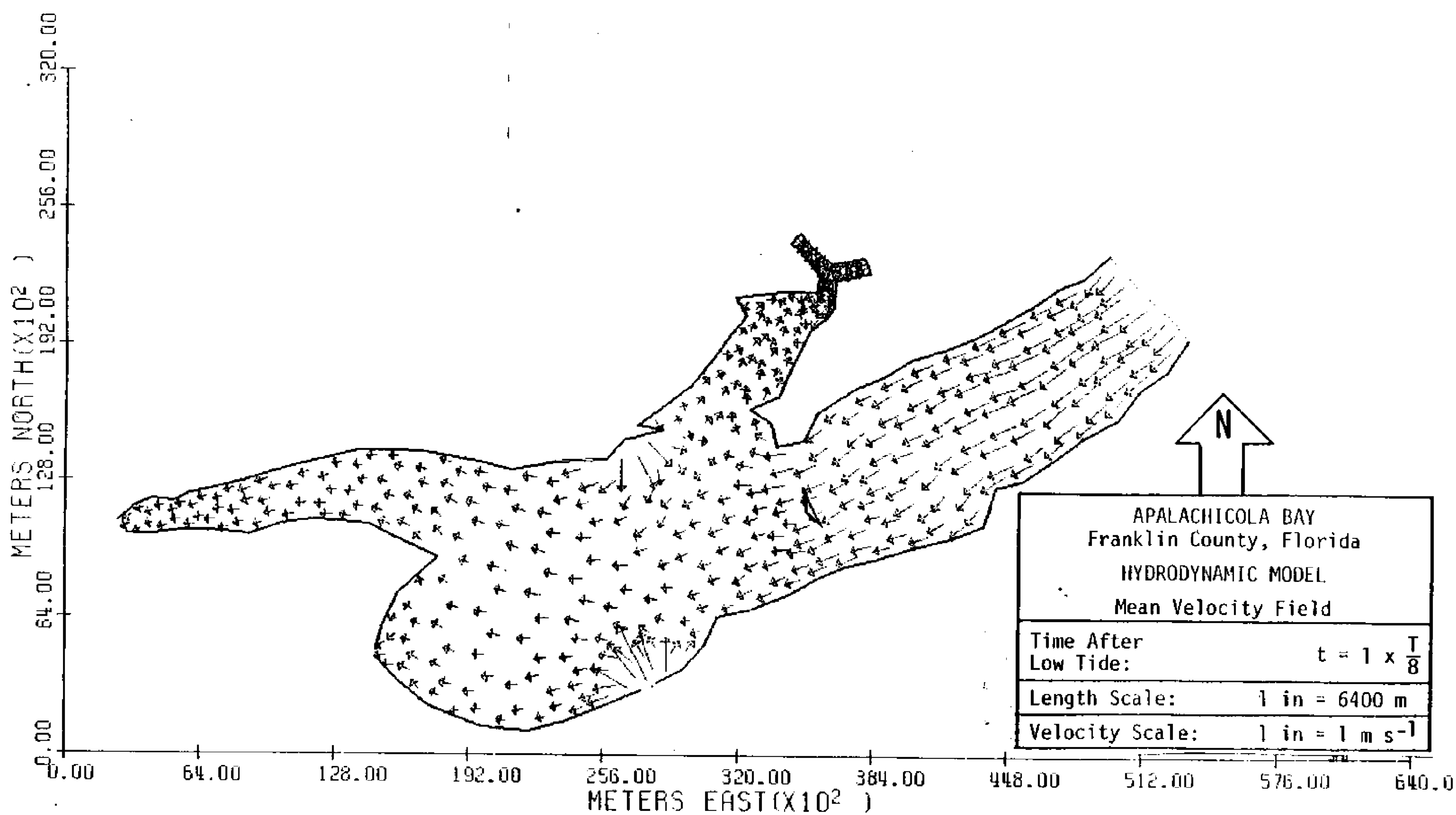
DECEMBER

DEC 1 through DEC 8:	Vertically averaged velocities v_m given at time increments equal to one eighth of the tidal period beginning at low tide.
DEC 9:	Net values of vertically averaged velocities. Time averaged over one tidal cycle.
DEC 10 through DEC 17:	Vertically averaged pollutant concentration corresponding to river concentration c_R = 100 and concentration c_o = 0 at all inlets to bay. Concentrations given at time increments equal to one eighth of the tidal period beginning at low tide.

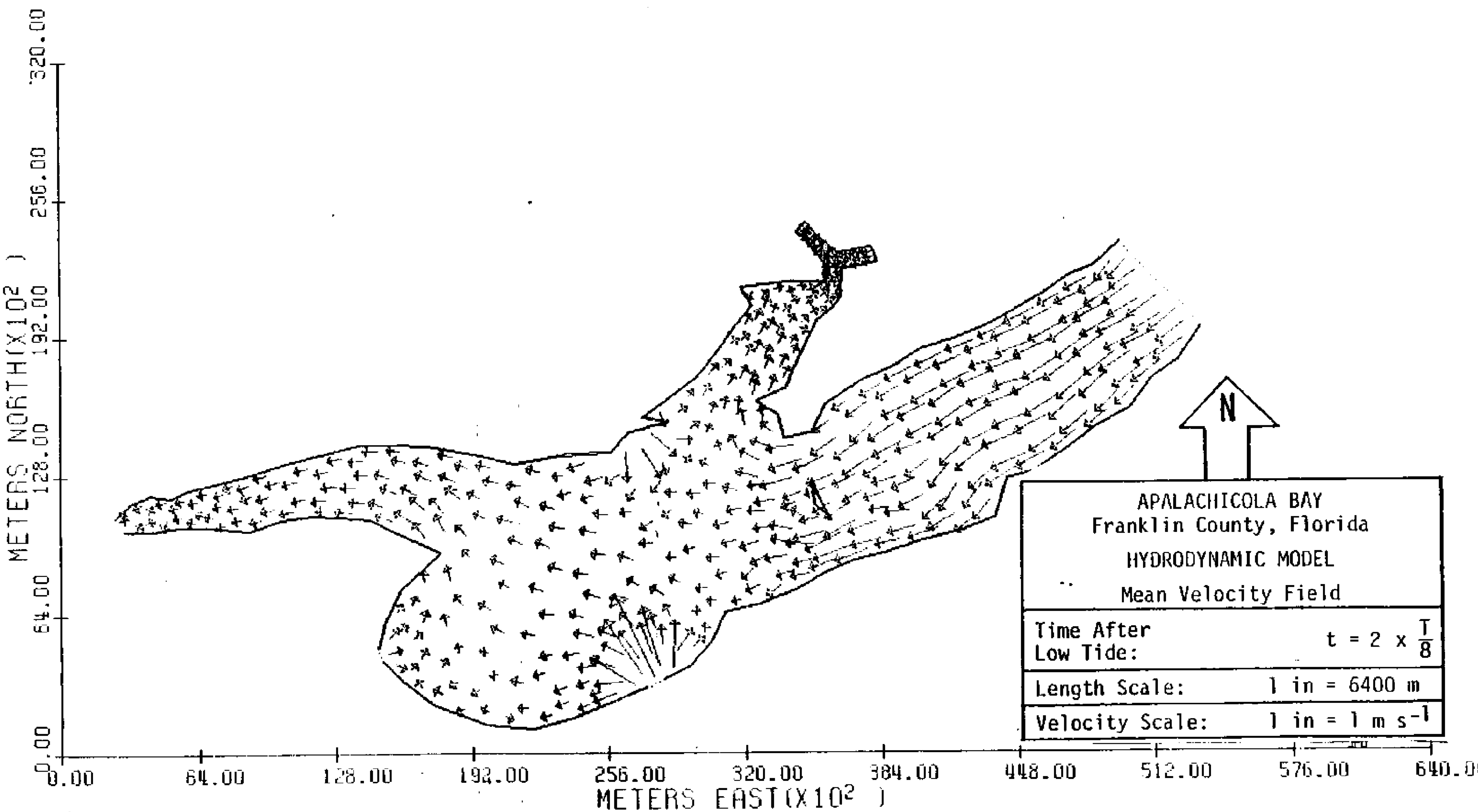


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 0 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

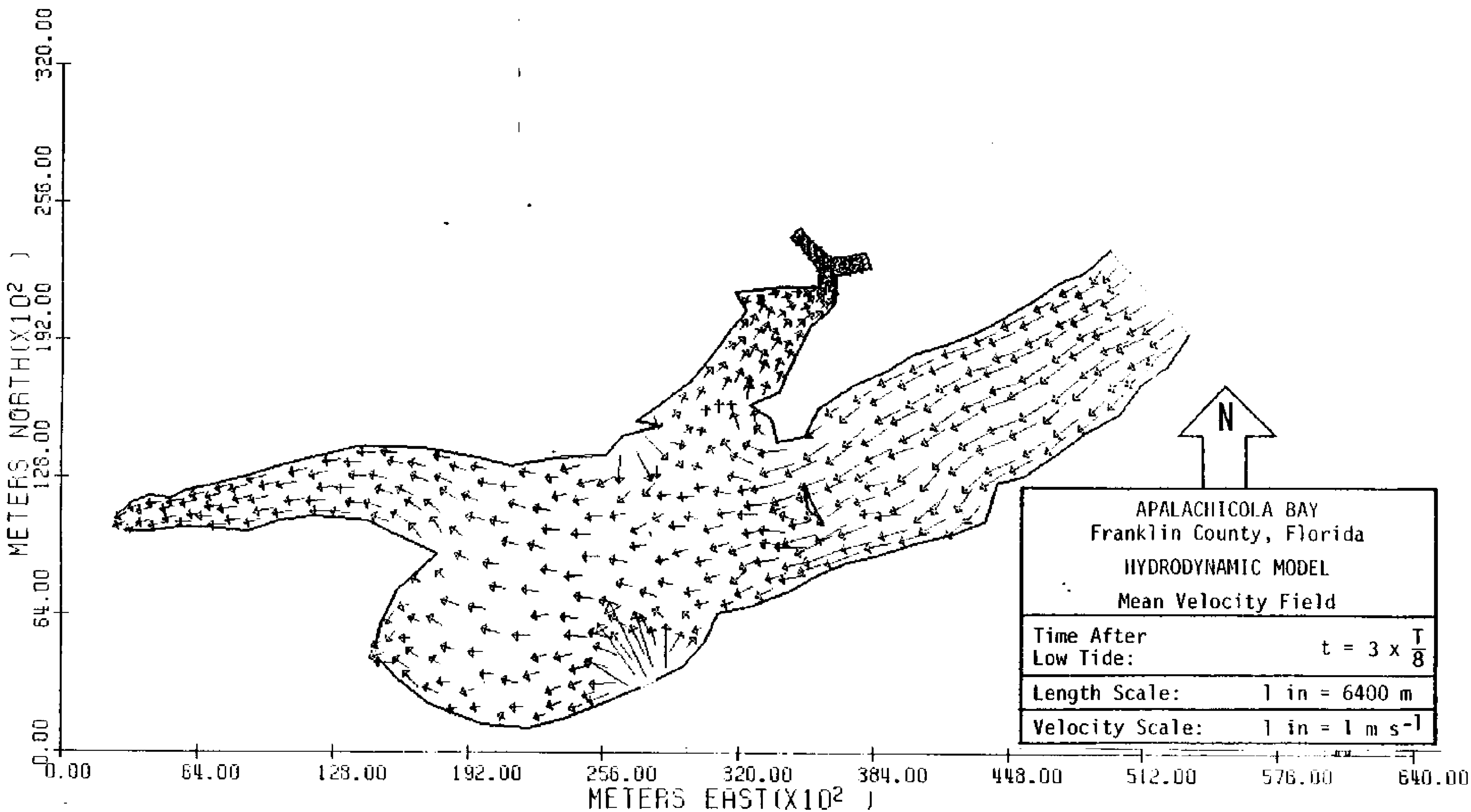
DEC 1


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 1 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

DEC 2

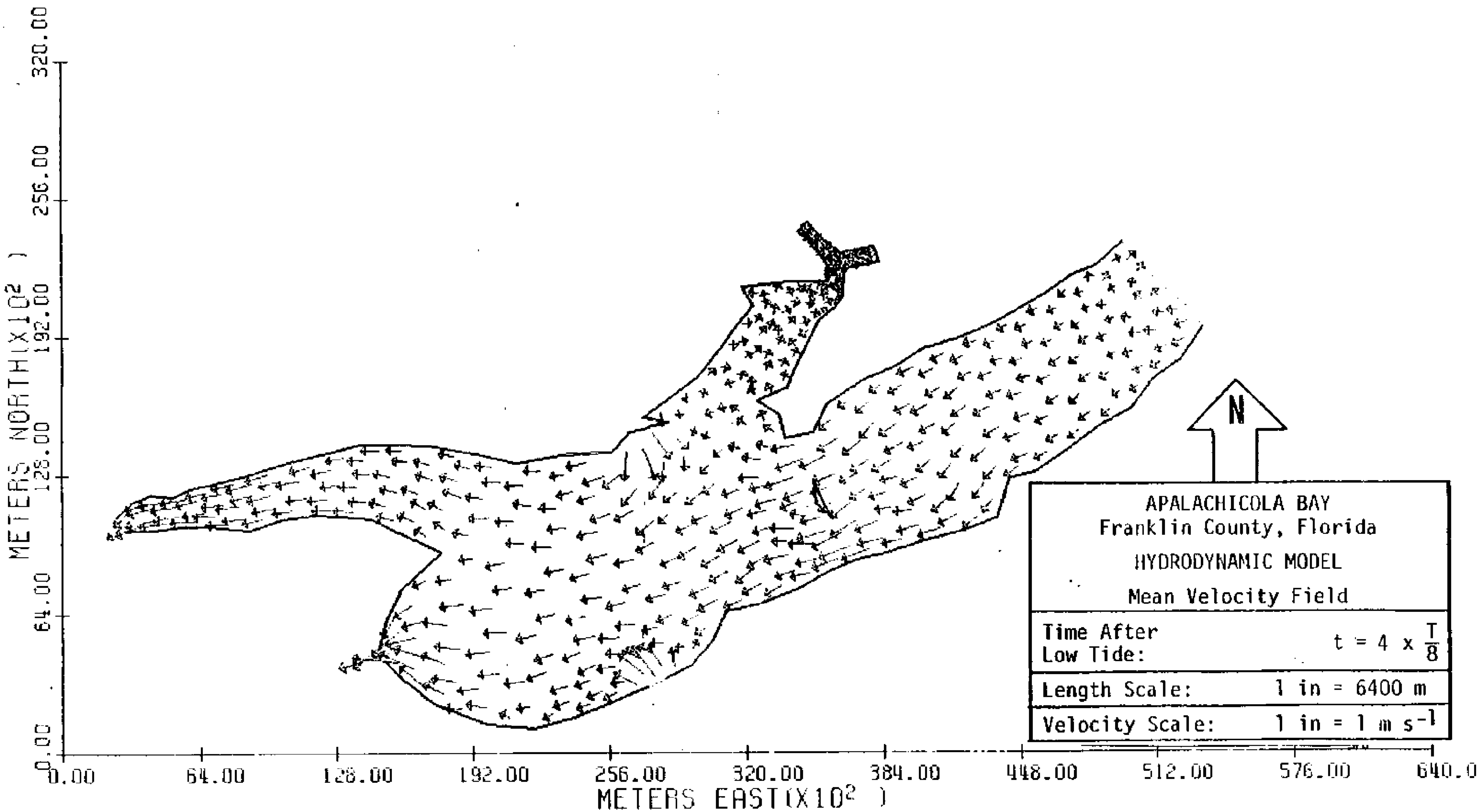

APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 2 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

DEC 3

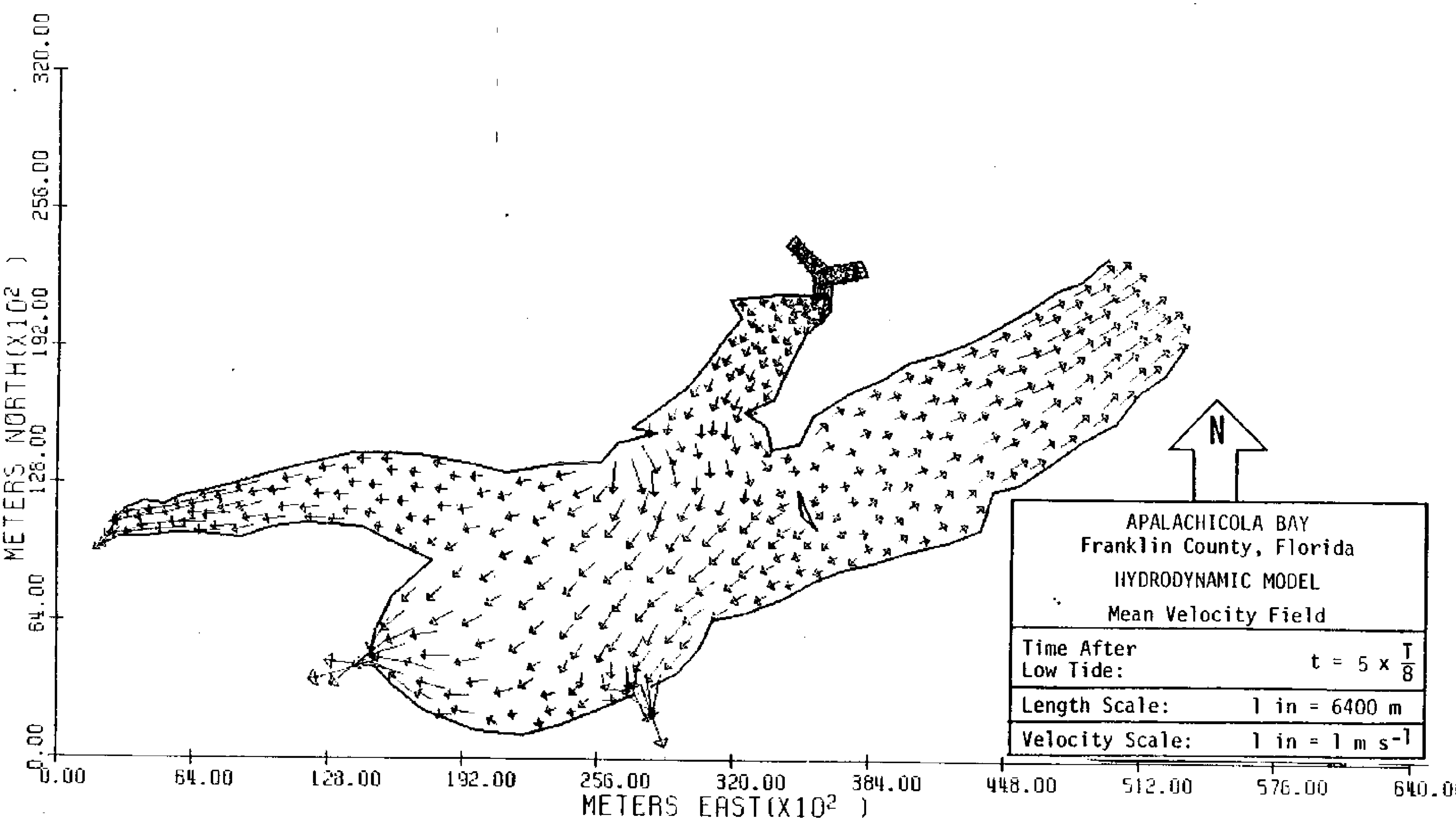


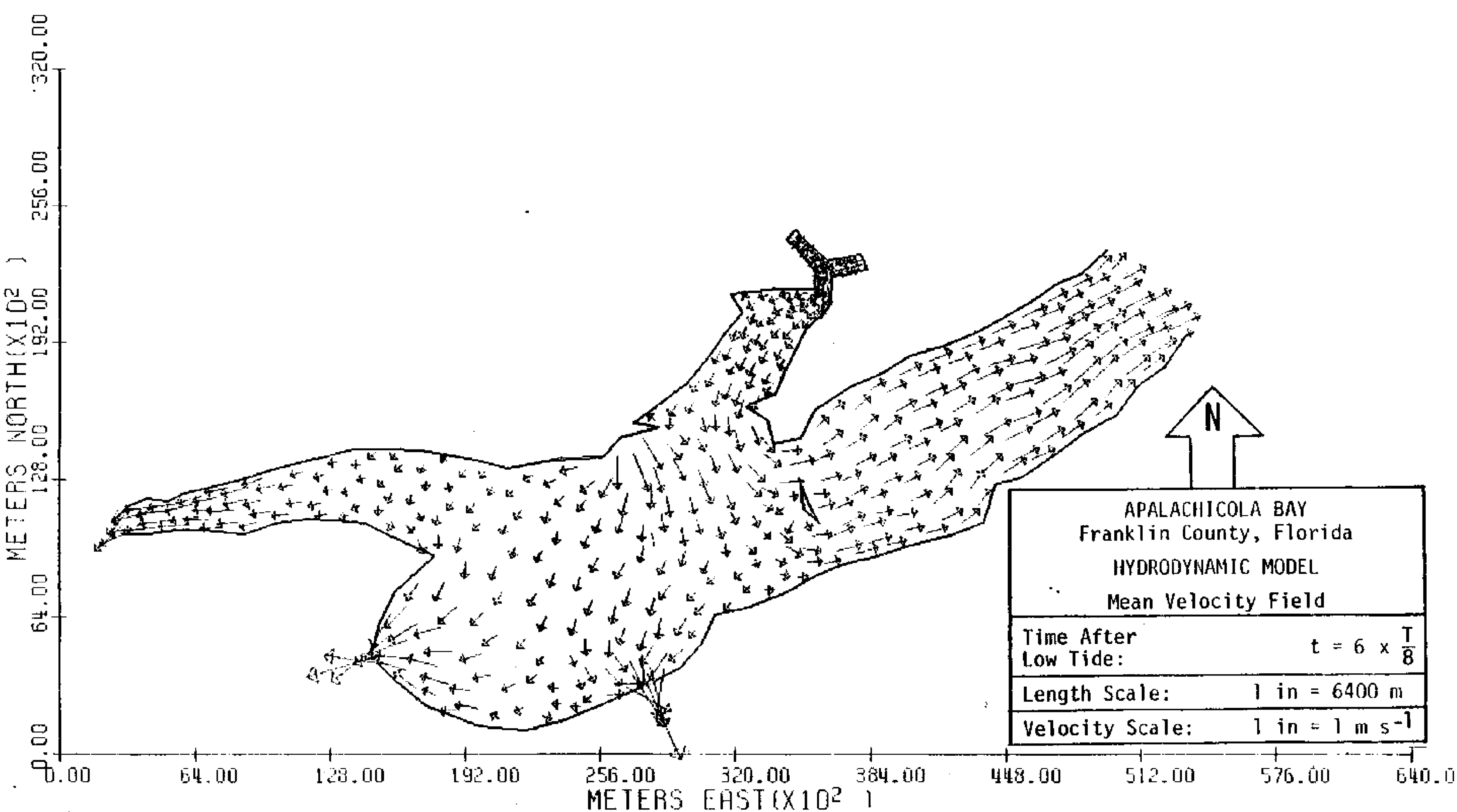
APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide:
$t = 3 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

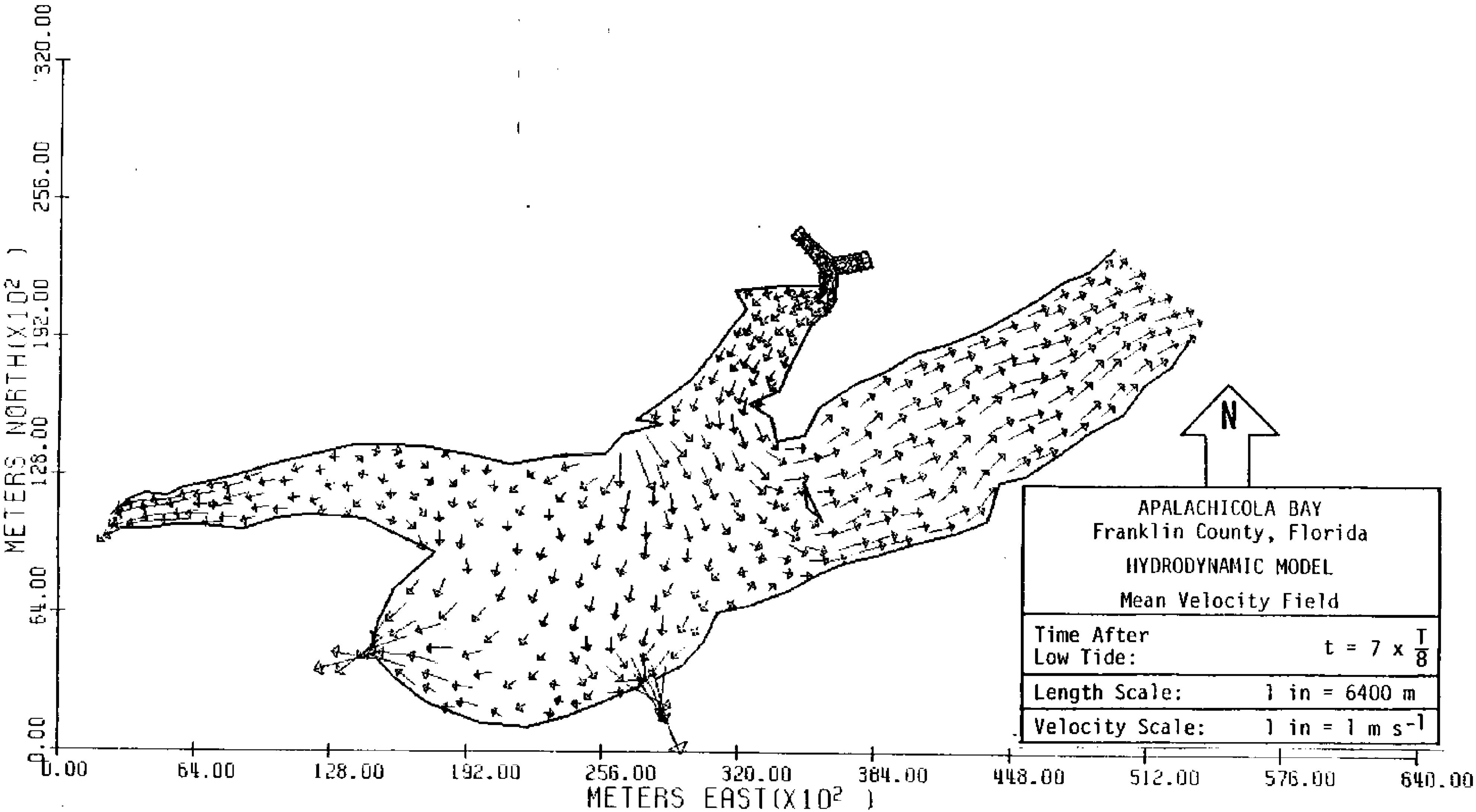
DEC 4


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 4 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

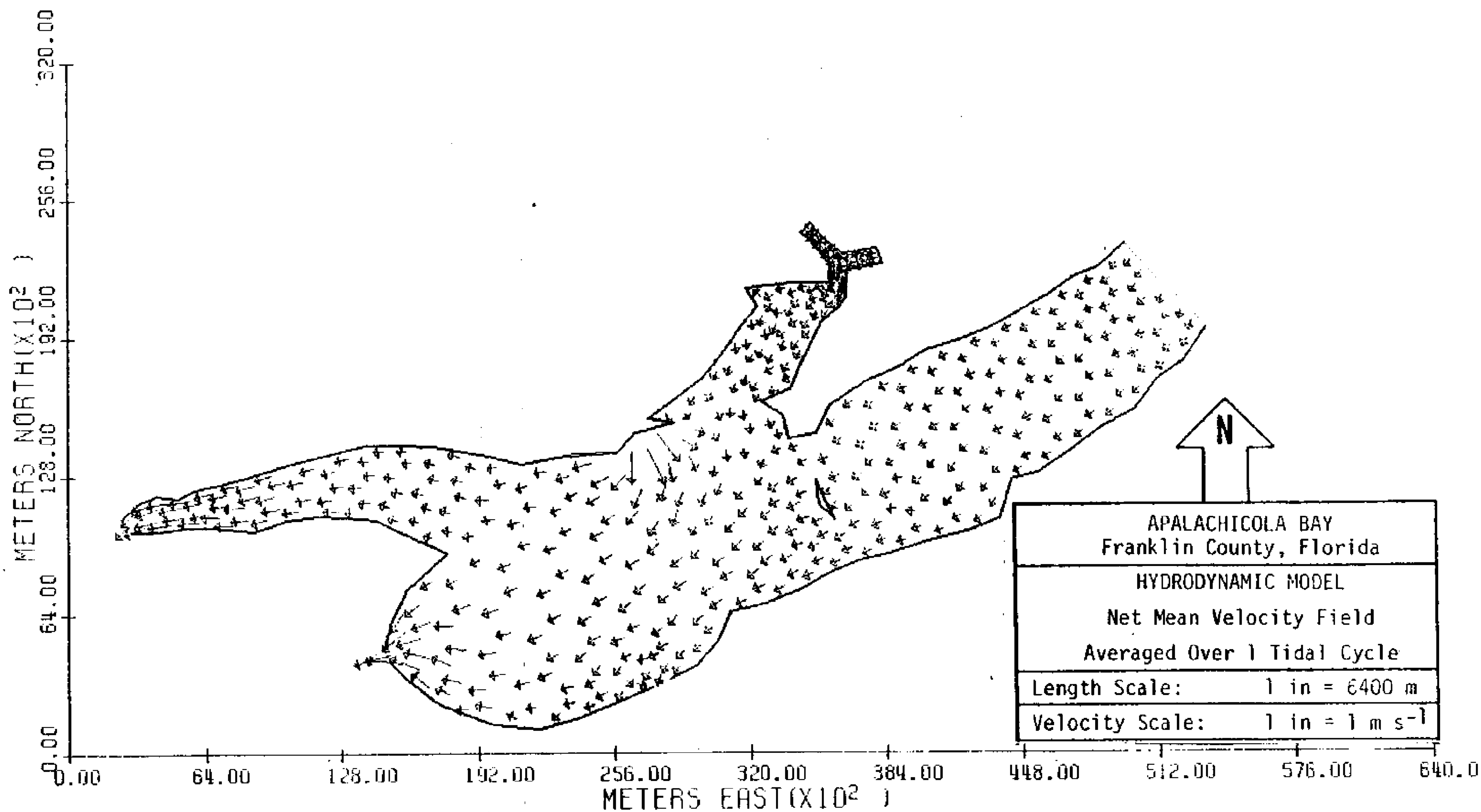
DEC 5


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 5 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00
DEC 6

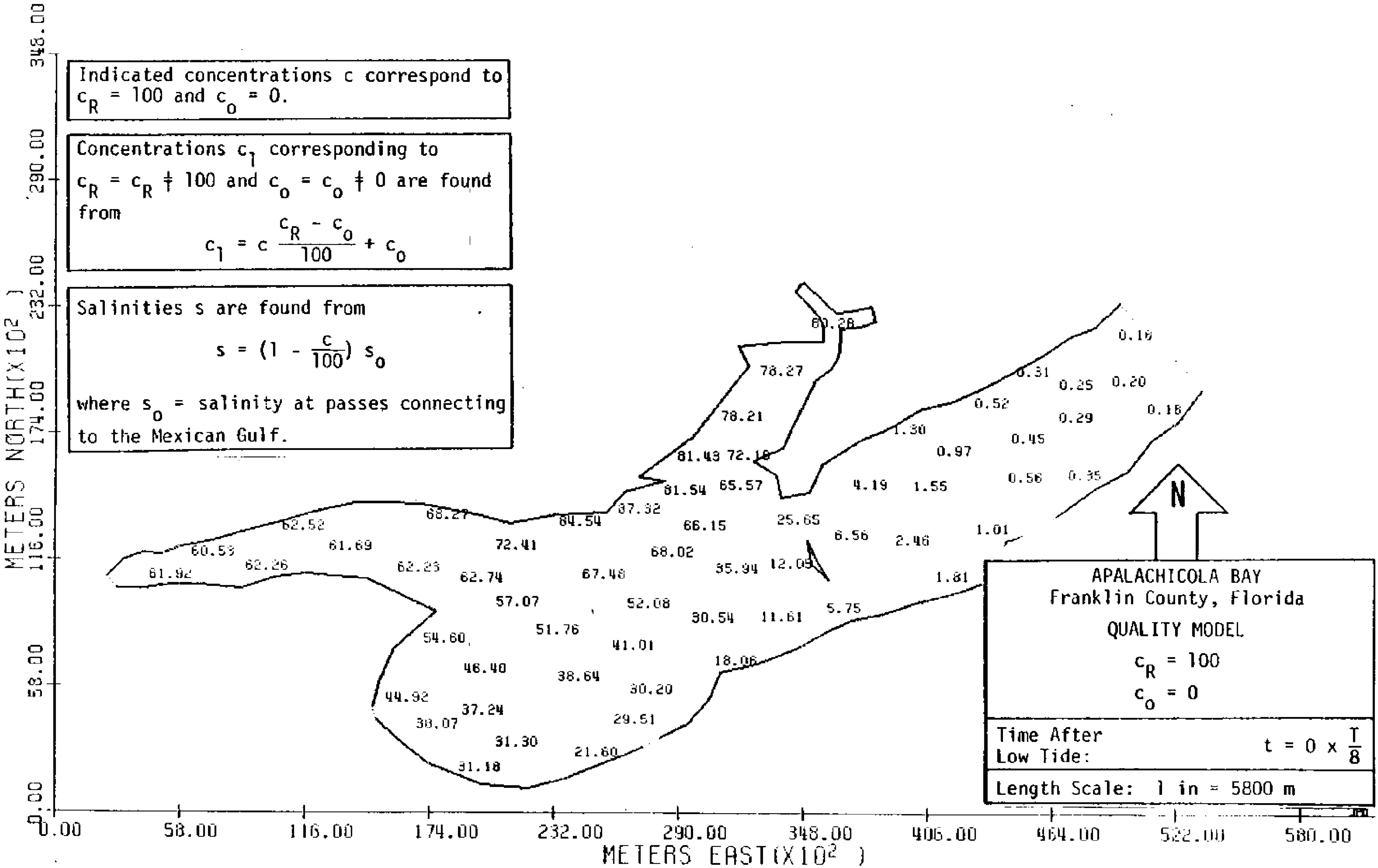

APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: $t = 6 \times \frac{T}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s^{-1}
N
METERS NORTH($X10^2$)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST($X10^2$)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00
DEC 7


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Mean Velocity Field
Time After Low Tide: t = 7 x T/8
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

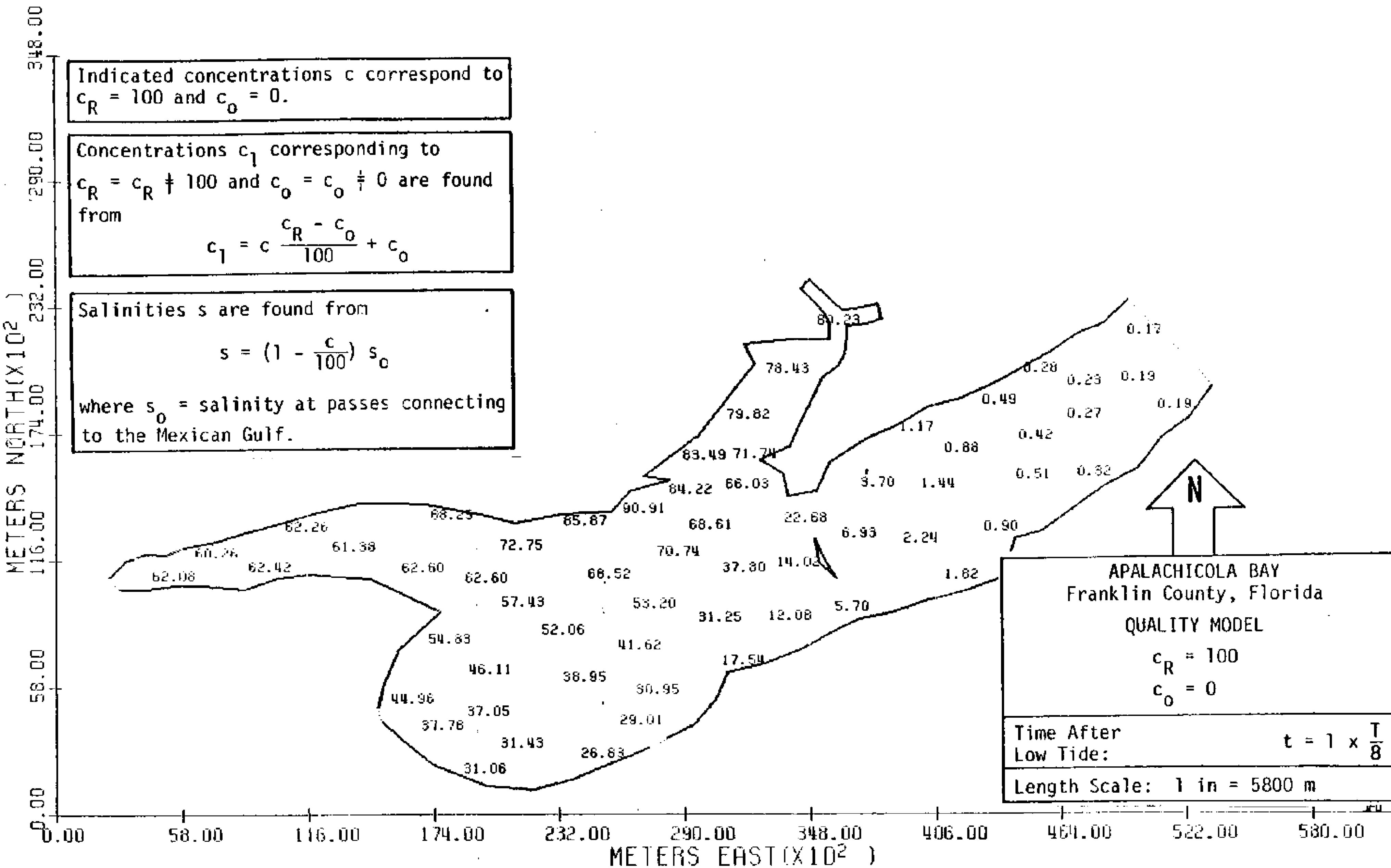
DEC 8


APALACHICOLA BAY
Franklin County, Florida
HYDRODYNAMIC MODEL
Net Mean Velocity Field
Averaged Over 1 Tidal Cycle
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s-1
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
64.00
128.00
192.00
256.00
320.00
384.00
448.00
512.00
576.00
640.00

DEC 9

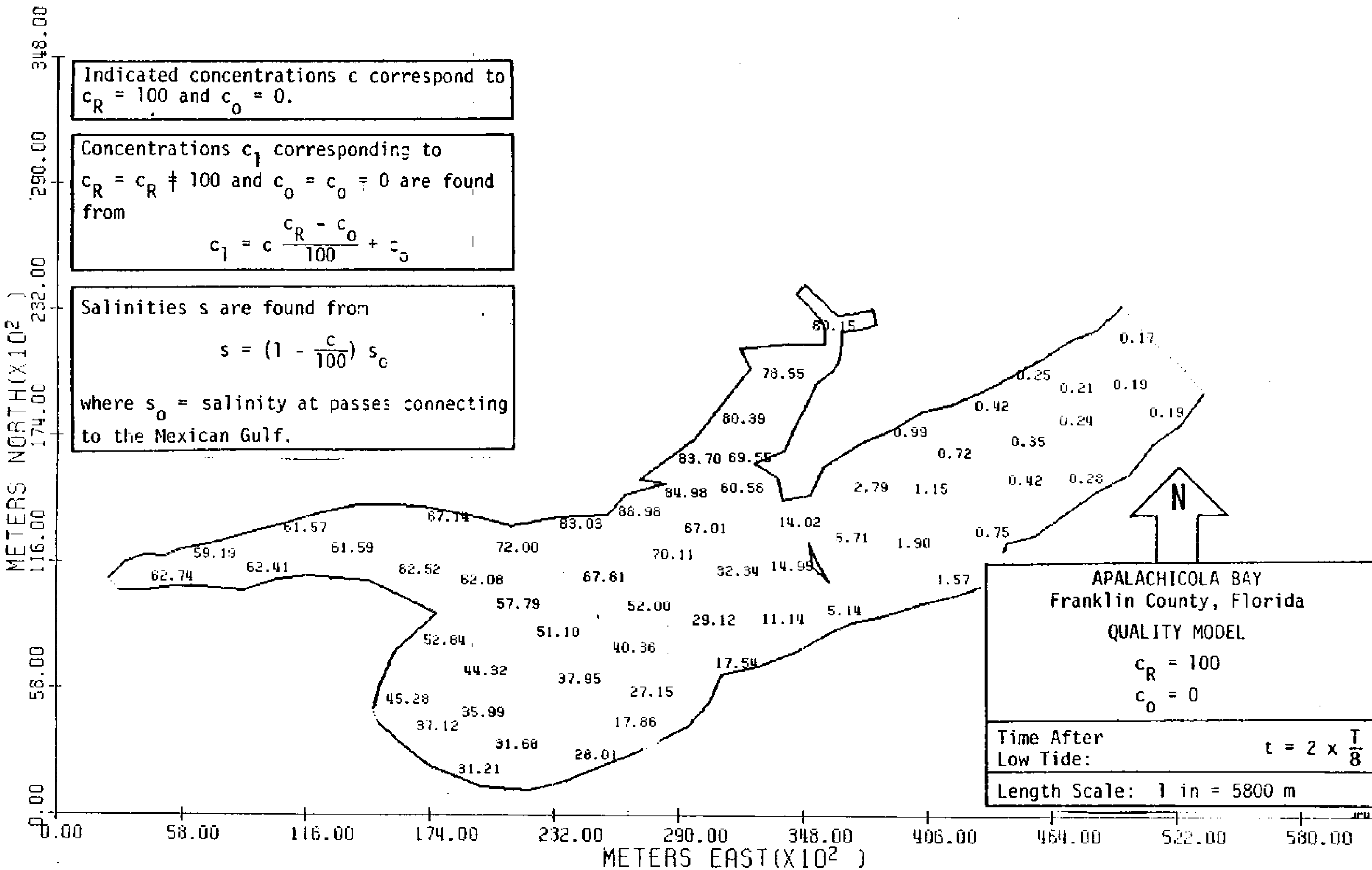

Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100})\, s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_o = 0$
Time After Low Tide:
$t = 0 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
80.28
78.27
78.21
81.43
72.18
81.54
65.57
87.32
84.54
68.27
62.52
60.53
61.92
62.26
61.69
62.23
72.41
62.74
66.15
68.02
67.48
57.07
54.60
51.76
52.08
46.40
44.92
38.64
41.01
37.24
38.07
31.30
31.18
21.60
29.51
30.20
30.54
35.94
25.65
12.05
11.61
18.06
5.75
6.56
4.19
2.46
1.55
1.30
0.97
1.01
1.81
0.52
0.45
0.56
0.31
0.25
0.29
0.35
0.20
0.16
0.18

DEC 10



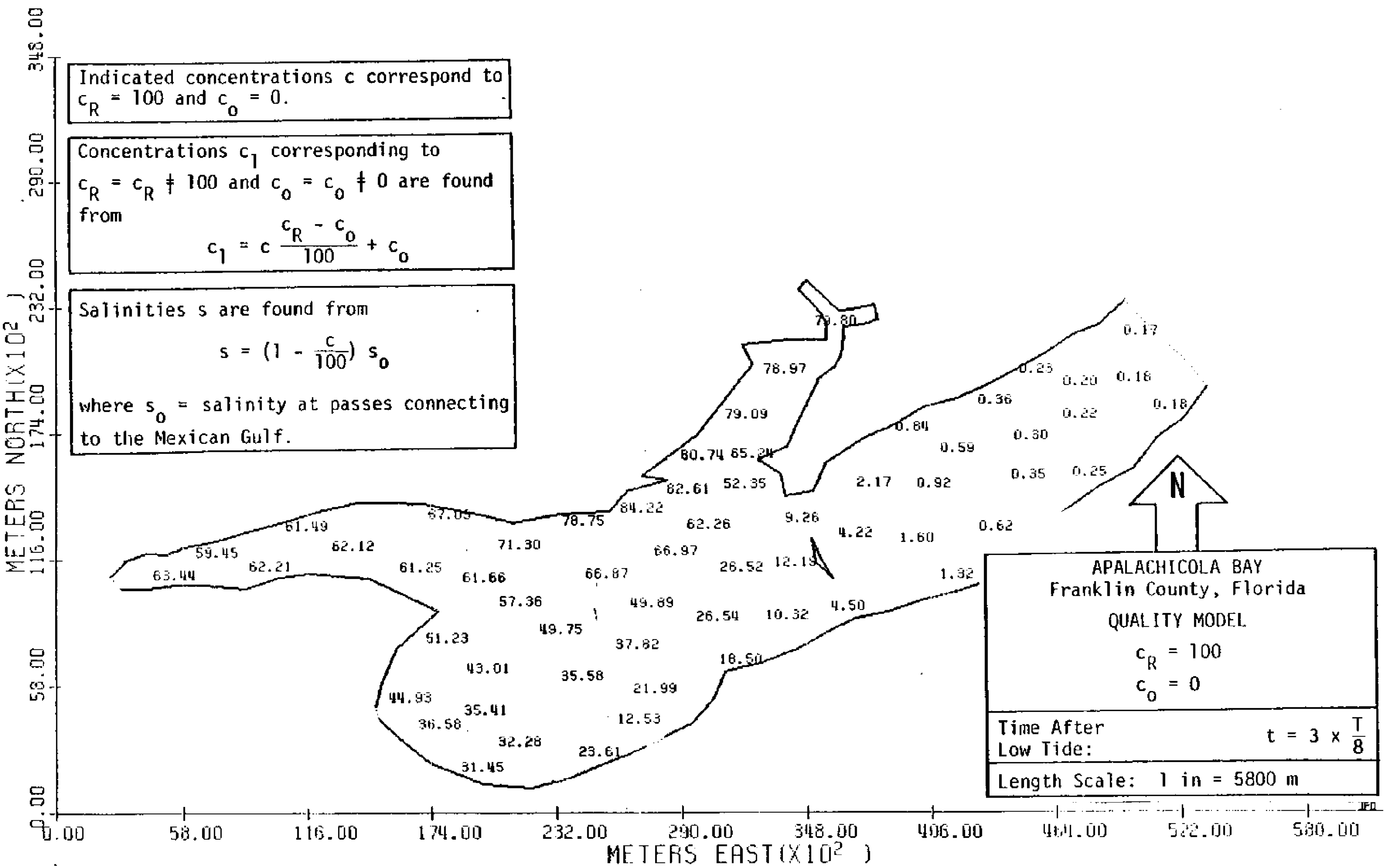
Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 1 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
62.08
62.42
62.26
61.38
68.25
72.75
62.60
62.60
57.43
54.83
46.11
44.96
37.05
37.76
31.43
31.06
52.06
38.95
26.83
29.01
30.95
41.62
53.20
68.52
85.87
90.91
84.22
83.49
71.74
79.82
78.43
66.03
68.61
70.74
37.80
31.25
12.08
14.03
22.68
6.93
5.70
17.54
3.70
2.24
1.44
1.17
0.88
1.82
0.90
0.51
0.42
0.49
0.28
0.25
0.27
0.32
0.19
0.19
0.17

DEC 11

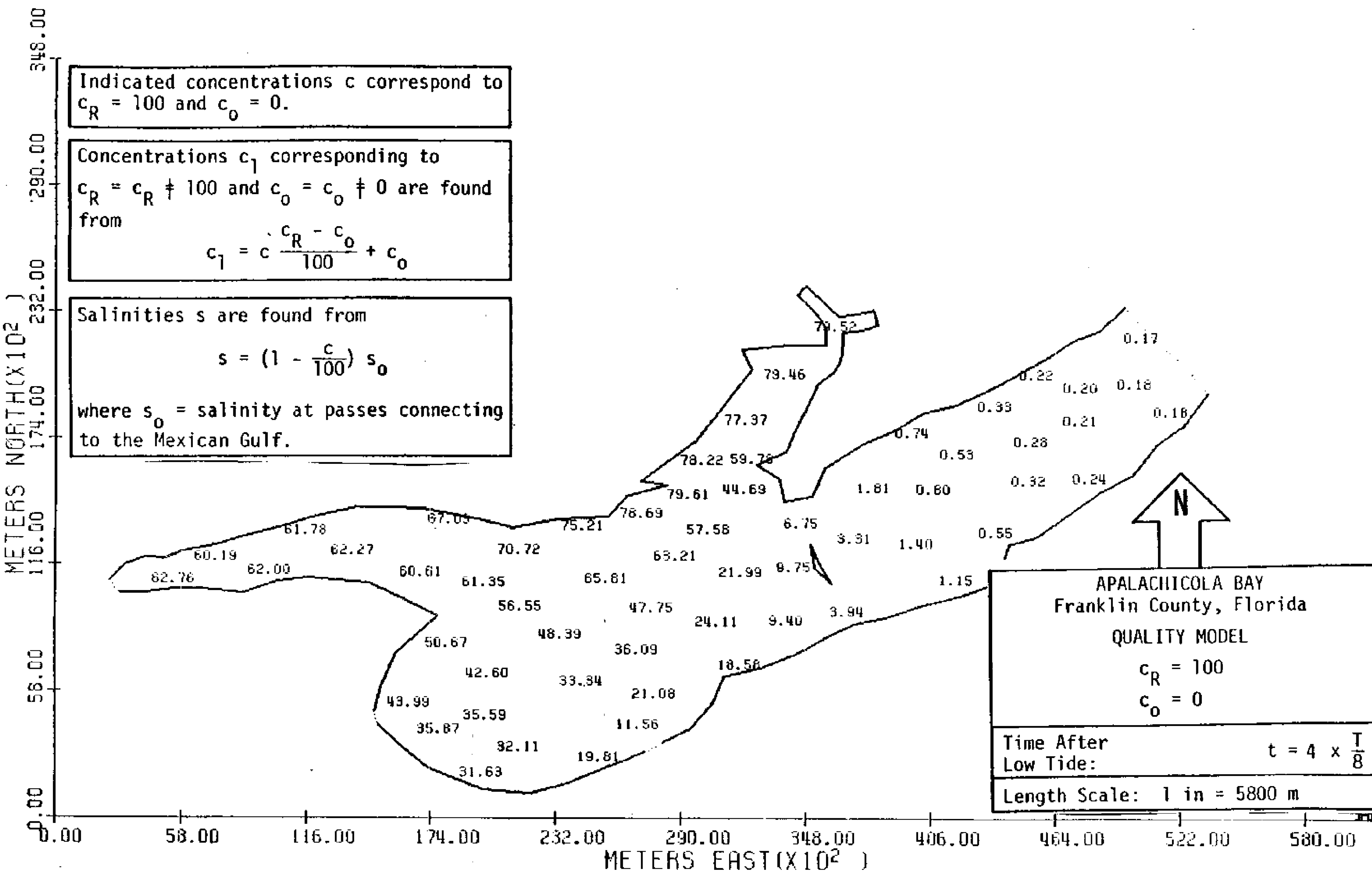


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100})\, s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 2 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
62.74
59.19
62.41
61.57
61.59
62.52
67.14
62.08
72.00
57.79
52.64
44.32
45.28
35.99
37.12
31.21
31.68
51.10
37.95
28.01
17.86
27.15
40.36
52.00
67.61
83.03
86.96
84.98
83.70
69.55
80.39
78.55
80.15
60.56
67.01
70.11
32.34
29.12
17.54
11.14
14.99
14.02
5.71
5.14
2.79
1.15
1.90
1.57
0.99
0.72
0.42
0.35
0.25
0.21
0.24
0.42
0.28
0.75
0.17
0.19
0.19

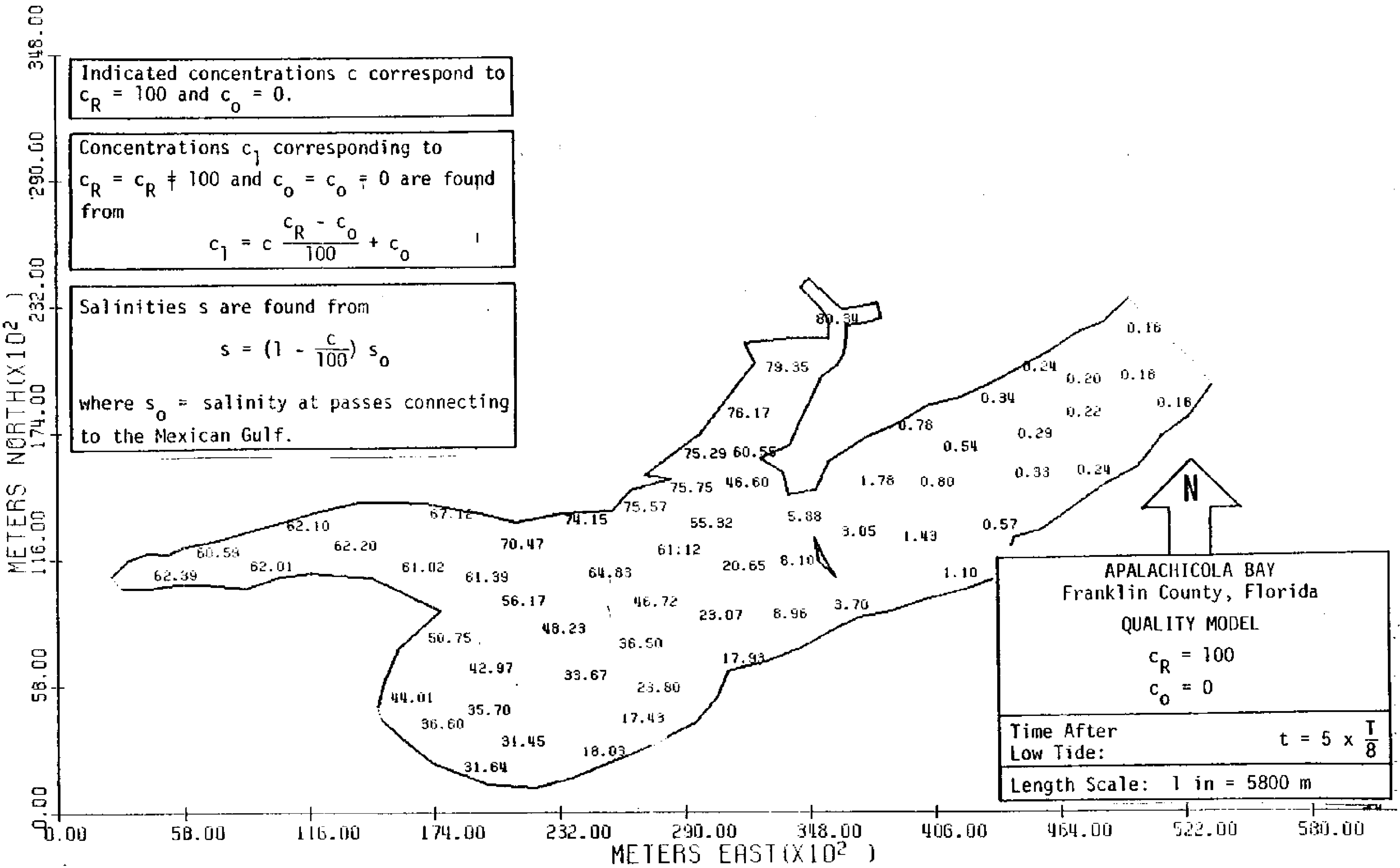
DEC 12


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c\,\frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = \left(1 - \frac{c}{100}\right) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide: $t = 3 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10^2)
METERS EAST(X10^2)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
63.44
59.45
62.21
61.49
62.12
61.25
61.66
71.30
57.36
51.23
43.01
44.93
36.58
35.41
32.28
31.45
49.75
35.58
23.61
12.53
21.99
37.82
49.89
66.87
78.75
84.22
66.97
62.26
82.61
52.35
80.74
65.24
79.09
78.97
26.52
26.54
10.32
18.50
12.13
9.26
4.22
4.50
2.17
0.92
1.60
1.32
0.84
0.59
0.62
0.36
0.30
0.35
0.23
0.20
0.22
0.25
0.17
0.16
0.18

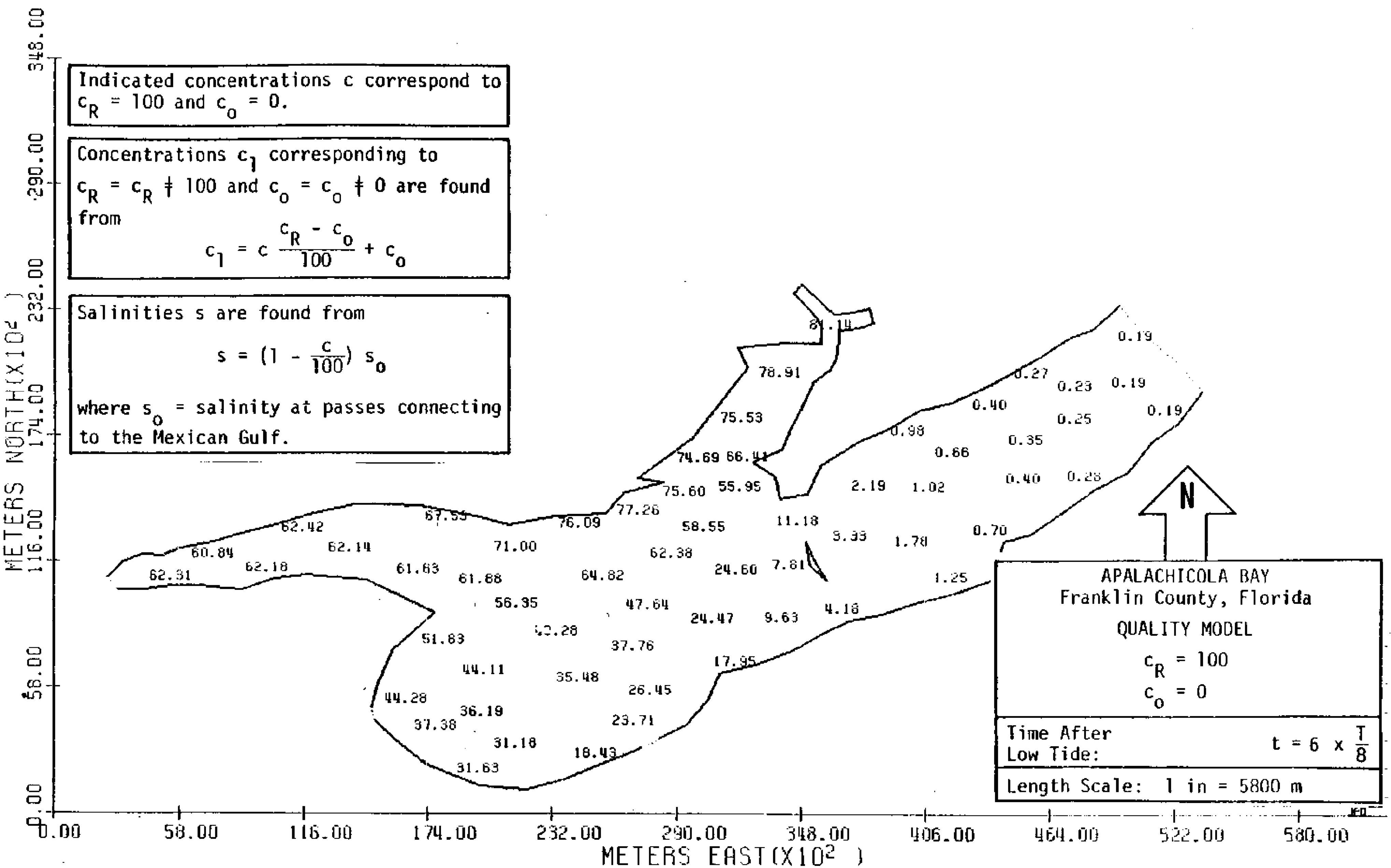
DEC 13


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c \frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = (1 - \frac{c}{100}) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 4 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
79.52
79.46
77.37
78.22
79.61
44.69
78.69
57.58
75.21
67.03
61.78
60.19
62.76
62.00
62.27
60.61
70.72
61.35
56.55
65.81
63.21
47.75
50.67
48.39
42.60
36.09
33.34
43.99
35.59
35.87
32.11
31.63
19.81
11.56
21.08
18.58
24.11
21.99
9.40
9.75
6.75
3.31
3.94
1.81
1.40
1.15
0.60
0.55
0.74
0.53
0.33
0.32
0.28
0.24
0.22
0.21
0.20
0.18
0.17
0.16

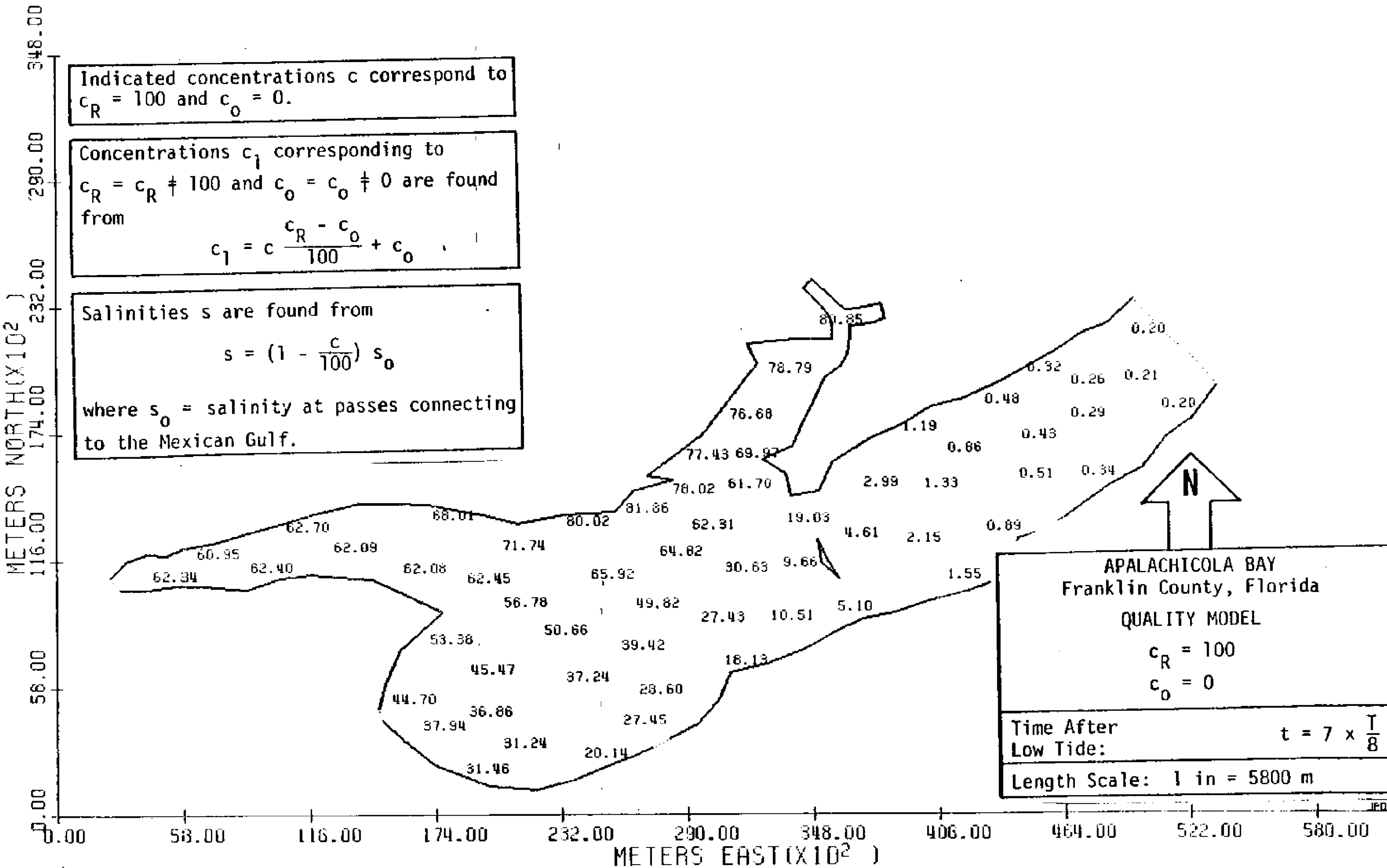
DEC 14


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$c_1 = c \frac{c_R - c_o}{100} + c_o$
Salinities s are found from
$s = (1 - \frac{c}{100}) s_o$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide:
$t = 5 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH(X10²)
METERS EAST(X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
80.34
79.35
76.17
75.29
60.55
75.75
46.60
75.57
74.15
67.12
62.10
60.58
62.39
62.01
62.20
61.02
70.47
61.39
56.17
64.83
55.32
61.12
46.72
20.65
5.88
8.10
23.07
8.96
3.70
50.75
48.23
36.50
42.97
33.67
17.93
23.80
44.01
35.70
36.60
31.45
17.43
18.03
31.64
1.78
0.80
3.05
1.43
0.57
1.10
0.78
0.54
0.34
0.29
0.33
0.24
0.24
0.20
0.22
0.16
0.16
0.16

DEC 15


Indicated concentrations c correspond to c_R = 100 and c_o = 0.
Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from
$$c_1 = c\,\frac{c_R - c_o}{100} + c_o$$
Salinities s are found from
$$s = \left(1 - \frac{c}{100}\right) s_o$$
where s_o = salinity at passes connecting to the Mexican Gulf.
APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
c_R = 100
c_o = 0
Time After Low Tide: $t = 6 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
N
METERS NORTH (X10²)
METERS EAST (X10²)
0.00
58.00
116.00
174.00
232.00
290.00
348.00
406.00
464.00
522.00
580.00
62.31
60.84
62.18
62.42
62.14
61.63
61.88
71.00
76.09
56.35
51.83
44.11
44.28
36.19
37.38
31.18
31.63
18.43
35.48
23.71
26.45
37.76
47.64
64.82
77.26
75.60
74.69
66.41
75.53
78.91
55.95
58.55
62.38
24.60
24.47
17.95
9.63
7.81
11.18
4.18
3.33
2.19
1.78
1.02
1.25
0.98
0.66
0.70
0.40
0.35
0.40
0.27
0.23
0.25
0.28
0.19
0.19
0.19

DEC 16



Indicated concentrations c correspond to $c_R = 100$ and $c_o = 0$.

Concentrations c_1 corresponding to $c_R = c_R \neq 100$ and $c_o = c_o \neq 0$ are found from

$$c_1 = c\,\frac{c_R - c_o}{100} + c_o$$

Salinities s are found from

$$s = \left(1 - \frac{c}{100}\right) s_o$$

where s_o = salinity at passes connecting to the Mexican Gulf.

DEC 17

APPENDIX B

A MAGNETIC TAPE OF THE COMPUTER PROGRAMS USED FOR THIS REPORT ALONG WITH EXPLANATIONS AND INSTRUCTIONS COMPRISE APPENDIX B

The tape contains FORTRAN programs constituting the hydrodynamic features model, the dispersion model and a plotting routine. The Hydraulics Laboratory used the following parameters to create the tape.

Tracks	9
Record Format	Fixed Block
Block Length	6160 Bytes
Record Length	80 Bytes
Density	6250 BPI
Labels	IBM Standard

A map of the tape follows.

Files 1, 2, 3, and 4 contain programs needed to prepare the data for use in the hydrodynamic features model. Files 5, 6, 7, and 8 represent the hydrodynamic features model, and files 9, 10, and 11 contain the dispersion model. File 12 comprises a Gould 5100 Electrostatic Plotter routine which can plot grid and element geometry, water surface elevation, velocity vectors and concentrations. The program files are a size convenient for storage in interactive terminal files.

The Hydraulics Laboratory user's instructions and sample job control used by the Hydraulics Laboratory for the two models and the plotting program on the University of Florida's Amdahl 470 V/6-II under OS MVS/SE and JES2/NJE system control also follow.

<u>SOURCE:</u> Massachusetts Institute of Technology Report No. 200

The program is designed to run without overlays. All arrays have object time dimensions and thus only the actual dimensions in the main program need to be changed. The variables used to determine the correct dimensions must be specified in main program. They are:

MAXNOD:	maximum number of nodes that program must handle
MAXEL:	" " " elements that program must handle
MAXL:	" " " nodes per land boundary
MAXO:	" " " " " ocean "
MAXBWH:	" band width. The program will print out the required bandwidth. Usually MAXBWH = .1·MAXNOD.
MAXBWQ:	2·MAXBWH
MAXBEL:	maximum number of element sides in total boundary
MAXHBN:	maximum number of prescribed surface elevation nodes
MAXQBN:	" " " " flow nodes
MAXHTC:	" " " half tide curves times two

The dimensions should be assigned as follows:

```
  DIMENSION TITLE(20),TEXT1(2,2),TEXT2(2,2),TEXT3(2,2),
1  ICON(MAXEL,3),A(MAXEL,3),B(MAXEL,3),AREA(MAXEL),NELM(MAXEL),
2  NEXT(MAXNOD),NINT(MAXNOD),XORD(MAXNOD),YORD(MAXNOD),DEPTH(MAXNOD),
                                                         NBC(MAXNOD),
3  SYSMH(MAXNOD,MAXBWH),SYSMQ(2*MAXNOD,MAXBWQ),
4  H(MAXNOD),Q(2*MAXNOD),HPREV(MAXNOD),QPREV(2*MAXNOD),
5  SYSFH(MAXNOD),SYSFQ(2*MAXNOD),
6  SYSBMH(2*MAXHBN,MAXBWH),SYSBMQ(2*MAXQBN,MAXBWQ),NHN(MAXHBN),
                                         NQN(MAXQBN)MNVN(10),
7  HB(MAXHBN),ALAG(MAXHBN),QB(MAXQBN),QBANG(MAXQBN),TAUWX(MAXNOD),
                                                      TAUWY(MAXNOD),
8  PSPLUS(MAXNOD),CF(MAXEL),EDXX(MAXEL),EDDY(MAXEL),NILM(MAXEL),
                                                    NBN(3*MAXBEL),
9  EDXY(MAXEL),HTC(MAXHBN,MAXHTC),IPNT(MAXHBN),NFLUX(30),FLUX(30),
                                                          WS(MAXHBN)
  DIMENSION ETA(MAXNOD),U(MAXNOD),V(MAXNOD),ETAPRV(MAXNOD),DELRO(MAXNOD),
1  NMLBN(3),ICONL(3,MAXL),NMBMPB(3),ICONB(3,MAXO),DISCHS(MAXO),CBDIS(4)
```

For special tidal and wind forcing the subroutines STETAB and WINDS can be modified.

<u>ALTER DIMENSIONS IN SUBROUTINE FORCEQ</u>

Input:

CARD GROUP 1 Parameters and Options. One Card (16I5)

IVERSN	= 1	
NMEL		number of elements
NMNP		number of node points
IBFRIC	= 1,	Variable bottom friction coefficient, values to be read for each element, see card group 4
	= 2,	constant bottom friction coefficient, value of first element used, see card group 4
IDEPTH	= 1,	variable depth, values to be read for each node, see card group 3
	= 2,	constant depth, value of first node used, see card group 3
IEDVIS	= 1,	variable viscosity coefficient } value as for IBFRIC
	= 2,	constant viscosity coefficient }
IWIND	= 1,	variable wind stress
	= 2,	constant wind stress
INPUTH	= 1,	ETA set to zero, (cold start)
	= 2,	ETA to be read in, (hot start)
INPUTQ	= 1,	Q set to zero, (cold start)
	= 2,	Q to be read in, (hot start)
ICNVEC	= 1,	Convective terms ignored
	= 2,	Convective terms included
KSTART	=	time step at which output will begin to be written on disc
KSTPR	=	interval (in time steps) between output to disc of velocities
KDISC	=	Not used
IMWS	= 1,	Subroutine SETMWS is called to establish MWS
	= 2,	mean low water is same as datum
IHTC	= 1,	tides specified with half tide curves
	= 2,	tides sinusoidal
IREF	=	Node [illegible] reference datum when IMWS = 1

CARD GROUP 2 Title. One Card (20A4)

CARD GROUP 3 Nodal Information. NMNP Cards (2I5, 7F10.0)

I = 1, NMNP, 1

NEXT(I) external node number. NEXT(I) should be input so that NBAND, the bandwidth is minimized

NBAND = maximum over all elements (I = 1, NMEL) of 1 plus maximum internal node number of element I minus the minimum internal node number of element I, where the internal node number, NINT(I), is determined by the ordering during read in: NINT(NEXT(I)) = I, I = 1, NMNP.

NBC(I) node code

= 0 internal node

= 1 prescribed normal flow

= 2 prescribed height

= 3 prescribed height and normal flow

= 4 prescribed normal and tangential flow (≡0)

= 5 prescribed height and both flows

= 6 source/sink node

= 7 source/sink node with prescribed normal flow

= 8 source/sink node with both flows set to zero

XORD(I) x - coordinate

YORD(I) y - coordinate

DEPTH(I) bottom depth referred to datum (usually MLW). Positive if bottom is below datum, negative if above.

DUM1, DUM2, DUM3, DUM4 } dummy variables used to input prescribed values according to NBC as described below:

NBC = 0 not used

DUM1 = QB, DUM2 = QBANG

DUM1 = HB, DUM2 = ALAG

DUM1 = HB, DUM2 = ALAG, DUM3 = QB, DUM4 = QBANG

DUM1 = QB, DUM2 = QBANG

5 DUM1 = HB DUM2 = ALAG, DUM3 = QB, DUM4 = QBANG

6 DUM1 = FLUX

7 DUM1 = FLUX, DUM2 = QB, DUM3 = QBANG

8 DUM1 = FLUX

where: QB is local x flow

QBANG is the angle from x-axis to outward normal at node. The direction of the normal is determined by requiring net flow across adjoining segments to vanish.

H' is tidal amplitude

ALAG is time lag

FLUX is source flux, m^3/sec

CARD GROUP 4 Element Data. NMEL Cards, (4I10, 4F10.0)

I = 1, NMEL, 1

NELM(I) external element number

ICON (I,1)
ICON (I,2)
ICON (I,3) } external node numbers e1, e2, e3 in sense from x toward y.

CF(I) bottom friction coefficient, note: if CF(1) > 1. and IF... [illegible]
then CF(1) - 1. is taken as Mannings
n throughout.

EDXX(I)
EDYY(I)
EDXY(I) } eddy viscosities

CARD GROUP 5 System Properties. One Card (F10.0, E10.3, 3F10.0)

ALATT	latitude north
OMEGA	phase velocity of earth's rotation = .72722 x 10^{-4} sec^{-1}
GRAVT	gravitational acceleration (=9.81 m/sec^2)
PERIOD	period of tide, (not used if IHTC = 1)
DENSTY	average density of water

CARD GROUP 6. Integration Parameters. One Card(3F10.0, I10, F10.0, 2I10)

STRTIM	start time of integration
ENDTIM	end time of integration
TINC	time increment
NØ	external node number for which stability is checked (Ø = zero)
BOUND	bound on height variation at node NØ
IDT	parameter to be used for variable time stepping, use 1 since this has not yet been implemented
NOUT	hard copy output for every NOUT time steps
NMHTC	max number of half tide curves + 1

CARD GROUP 7 Land Boundary Data. One Card (8I10)

NMLB number of land boundaries

(NMLBN(I), I = 1, NMLB) number of nodes on each land boundary, including first and last

Card group 8: Segment connectivity. One Card per Boundary (20I4)

I = 1, NMLB

(ICONL(I,J), J = 1, NMLBN(I) external node numbers on boundary in sequential order such that area is to left of direction of advance

Card group 9: Ocean Boundary Data. One Card (8I10)

NSEGMT number of ocean boundaries

(NMHNPB (I), I = 1, NSEGMT) number of height nodes on ocean boundary, including first and last

Card group 10: Segment Connectivity. One Card per Boundary (20I4)

I = 1, NSEGMT

(ICONB(I,J), J = 1, NMHNPB(I)) external node numbers on ocean boundary in sequential order such that area is to left of direction of advance

Card group 11: Boundary elements

First card (I10)

NMBEL number of sides of total boundary

Next cards (20I4)

NBN(I) I = 1, 3*NMBEL, element and two node numbers corresponding to each side.

Card group 12: Wind information. One card (2F10.0)

WINDSP Wind speed in [m/sec]. Note: the wind drag coefficient assumes WINDSP is in [m/sec].

WDIRC Wind direction (blowing from!) relative to x-axis in degrees.

Card group 13: Mass storage file specifications. One card (8I10)

IUNITQ = File unit number for discharges

NRECQ = Number of records in file IUNITQ

NSIZEQ = Record size in file IUNITQ

IPOINT = Record pointer in file IUNITQ (usually = 1)

(Ex. DEFINE FILE IUNITQ (NRECQ, NSIZEQ, U, IPOINT)

IUNITH = File unit number for depths

NRECH = Number of records in file IUNITH

NSIZEH = Record size in file IUNITH

KPOINT = Record pointer in file IUNITQ (usually = 1)

(Ex. DEFINE FILE IUNITH (NRECH, NSIZEH, U, KPOINT)

Only if

IHTC = 1 include data for each ocean boundary node in the sequence that the boundary nodes appear in the group 3 cards consisting of 2*(NMHTC) values. The first two values should be zero. (8F10.0)

(I = 1, NMHBN)

HTC(I,J) J = 1,2*(NMHTC) consist of pairs of amplitude and time.

Only if

INPUTH = 2 include data for initial values of heights

((NMNP - 1)/8 + 1) cards (8F10.0)

(ETA(I), I = 1, NMNP) initial surface elevations, internal in node ordering.

Only if

INPUTQ = 2 include data for initial values of flows

((2*NMNP - 1)/8 + 1) cards (8F10.0)

(Q(I), I = 1, 2*NMNP) initial flows in pairs of x- and y-components. Internal node ordering.

Card group 14: Termination Card. One Card (16I5)

IVERSN = 0

Instead of termination card, which will stop the execution, input for a new problem may be inserted (repeat card groups 1 through 11).

SOURCE: Massachusetts Institute of Technology Report No. 218

The following describes the requirements of the 2-D vertically integrated dispersion model, DISPER. The model predicts contaminant concentration at the nodal points of a two dimensional finite element grid representing the solution field given the following information:

i) the geometry of the solution field in the form of a finite element grid, including the depth of each node.

ii) direct input, functional relations, or auxiliary program describing the circulation field over time, dispersion values and decay coefficients.

iii) location, duration, and strength of source and sink nodes, elements or sides.

iv) location, duration, and magnitude at prescribed concentration nodes (boundary conditions).

v) initial concentrations at each node (initial conditions).

The user may choose whatever units he wants to work with, as long as they are maintained in all the input. Units of mass (M), length (L), and time (T) are indicated in the input description.

The user must ascertain that the dimensioned arrays are sufficiently large. For this purpose and for transferring arrays to subroutines the following variables must be defined:

MAXNP Maximum number of nodes that can be handled by program. C1, C2, C3, F1, F2, P, XORD, YORD, DEPTH, SYSM, SYSB, NINT, NEXT, U, H, V, COE, P2

MAXEL Maximum number of elements that can be handled by program. ICON, AREA, A, B, ED, NELM, NILM.

MAXBS Maximum number of element sides with prescribed load. IB, QS.

MAXBN Maximum number of nodes with prescribed concentration. CNODE, NB.

MAXFE Maximum number of element with prescribed load. IPE, PE.

MAXFN Maximum number of nodes with prescribed load. IPN, PN.

MAXBW Maximum bandwidth of coefficient. The model will compute the necessary bandwidth for a given problem. See also card group 3. SYSM, SYSB.

MAXLB Maximum number of land boundaries. NLBN, ICONTU

MAXLBN Maximum number of nodes per land boundary. ICONTU

The arrays associated with each variable have been listed. In addition the following array should be dimensioned:

Q(2*MAXNP)

All arrays are transferred to subroutine as arguments and need only be dimensioned in the main program. Note, if the above maximum values exceed the values needed for a given problem no changes are necessary.

The following describes the specific input data requirements.

Card group 1: Title. One card (18A4)

Card group 2: Parameters and Options. One card (8I10)

NUMEL — Number of elements (not to exceed MAXEL set in main program)

NUMNP — number of nodes (not to exceed MAXNP)

NBSIDE — number of boundary sides with specified flux (not to exceed MAXBS)

NBNODE — number of nodes with specified concentration (not to exceed MAXBN)

NFLXE — number of source/sink elements (not to exceed MAXFE)

NFLXN — number of source/sink nodes (not to exceed MAXFN)

NFLAG { =0 constant boundary conditions over time
=1 varying boundary conditions over time }

Card group 3: Nodal Information. NUMNP cards (I5, 5X, 3F10.0)

M = 1, NUMNP

NEXT(M) external node number

The order in which these values are entered is important. The order must be such that the band width of the grid does not exceed the maximum specified value, MAXBW, in the main program. Internal node numbers are assigned to each node in the order in which they are read in. The band width is calculated as the maximum value of the difference between the highest and lowest internal node numbers for each element. For efficiency of storage, this value should be kept small.

XORD(M) x-coordinate of external node NEXT(M) (L)

YORD(M) y-coordinate of external node NEXT(M) (L)

DEPTH(M) depth at node NEXT(M) (L)

Card group 4: Element Data. NUMEL cards (4I10)

I = 1, NUMEL

N(I) element number (in ascending order)

ICON(N,1)
ICON(N,2)
ICON(N,3)
} external node numbers of the element given in sense of x toward y

Card group 5: Land boundaries. One card (8I10).

NMLB number of land boundaries

(NLBN(I), I = 1, NMLB) number of nodes in each boundary

For each boundary (I = 1, NMLB) (20I4)

ICONTU(J,I) nodes of boundary I in successive order when progressing such that the domain is to the left at the boundary. (J = 1, NLBN(I))

Card group 6: Prescribed loads and concentrations.

Only if NBSIDE > 0: Side Boundary Data. NBSIDE cards (2I10, F10.5)

I = 1 NBSIDE

IB(I,1)
IB(I,2)
} external node numbers at end points of side boundary I given so that area of interest is to left of direction of advance

QS(I) inward flux per unit length ($ML^{-2}T^{-1}$)

Only if NBNODE>0: Node Boundary Data. NBNODE cards (I10, F10.0)

I = 1, NBNODE

NB(I) external node number at which concentration is specified

CNODE(I) specified concentration at external node NB(I) (M/L^3)

Only if NFLXE > 0: Source/sink Elements. NFLXE cards (I10, F10.0)

I = 1, NFLXE

IPE(I) source/sink external node number

PE(I) specified inflow per unit standard area ($ML^{-2}T^{-1}$)

Only if NFLXN > 0: Source/sink Nodes. NFLXN cards (I10, E10.4)

I = 1, NFLXN

IPN(I) source/sink external node number

PN(I) specified inflow at external node IPN(I) (MT^{-1})

Card group 7: Integration Parameters and Options. One card (2F10.0 F15.0, 5, F10.5, 615)

STRTIM start time of integration

ENDTIM end time of integration

DT time increment

MAXIT maximum number of allowable iterations (should be 10 in most cases)

TOL tolerance for convergence (this is the normalized RMS error, .001 used in development work with satisfactory results)

NOUT hard copy output for every NOUT timesteps

IRUN run identifications number

IVEL
- = 1 constant uniform velocity field
- = 2 uniform velocity field with sinusoidal component
- = 3 velocity field read from direct across file. user should adjust subroutine VELSET for his own purposes.

IDIS
- = 1 constant dispersion coefficient with uniform given value
- = 2 variable dispersion coefficient determined in subroutine DISCO

IHOT
- = 1 values of initial concentration to be read in
- = 0 initial concentration set to zero

ICARD
- = 1 values of concentration will be punched after last iteration
- = 0 values of concentration will not be punched after last iteration

Card group 8A

Only if IVEL ≠ 3 include data for initial values of the velocity, tidal amplitude and tidal velocity angular frequency.

One card (4F10.3)

VTIM1 velocity in x direction

VTIM2 velocity in y direction

Only if IVEL = 2 AMP tidal velocity amplitude

OMEG tidal velocity angular frequency

Card group 8B

Only if IDIS = 1: One card (3F10.3, E10.3)

EXX, EYY, EXY: dispersion coefficients (L^2T^{-1})

WDECAY decay (T^{-1})

Card group 8C

Only if IDIS = 2: One card (2F10.3, E10.3)

CON1 longitudinal dispersion constant (L^2T^{-1})

CON2 lateral dispersion constant (L^2T^{-1})

DDECAY decay (T^{-1})

Card group 8D

Only if IHOT = 1: Integer (NUMNP/7) cards (7E11.4)

C1(III), III = 1, NUMNP initial concentration vector, in internal numbering order (i.e., the same order in which the nodes are read in)

Card group 9: Termination Card (F10.0)

STRTIM = -1.

Instead of a termination card, which will stop the execution, input for a new variation of card group 7 may be inserted (repeat Card groups 7 through 7D).

CAFE DATA PREPARATION PROGRAMS

These programs were written to assist the user in preparing the input data for CAFE. Their use will not only reduce the setup time for a new grid, but will ensure greater accuracy in the results. This set of programs includes:

- BOUNDELM - This program computes the boundary element data for CAFE (Card Group 2).
- QBANG - Computes values of QBANG for all land boundary nodes (in Card Group 3).
- NBAND - Computes internal node numbering for minimum band width.
- QBCOMP - Allows user to specify system inflows in units of cubic meters per second. QBCOMP will convert these units into those required by CAFE (m^2 sec^{-1}).

BOUNDELM

This program will determine the boundary element data required as input to CAFE. Inputs are: number of nodes, number of elements, element connectivity, and boundary data. The boundary element data are output in a form suitable for input to CAFE.

DIMENSIONING:

NMEL = number of elements

NMNP = number of nodes

#BNDS = number of separate boundary strings, land and water

MAX#NODS = mamimum number of nodes on any one boundary

#BNDELMS = maximum number of boundary elements

#OCNBNDS = number of ocean boundaries

Dimensions should be at least

NELM - (NMEL)

ICON - (NMEL, 3)

MEMEL = (NMNP, 8)

NMEM - (NMNP)

ICONB - (#BNDS, MAX#NODS)

NMBN - (#BNDS)

BNDARY - (#BNDELMS)

BNDELM - (#BNDELMS)

BNDNO1 - (#BNDELMS)

BNDNO2 - (#BNDELMS)

NMBNO - (#OCNBNDS)

Input Data:

Card Group 1: NMEL, NMNP One Card (2I5)

Card Group 2: Element Conectivity

Same as Card Group 5 in CAFE User's Manual.

Card Group 3: Boundary Data

Same as Card Groups 8, 9, 10 and 11 in CAFE User's Manual.

QBANG

This program will, upon input of the nodal and boundary information from CAFE, compute all values of QBANG and output correctly formatted CAFE node input data with values of NEXT, NBC, X, Y, DEPTH, and QBANG.

Dimensioning:

NMNP - number of node points

NMLB - number of land boundaries

NMLBN - maximum number of nodes on any land boundary

Inputs:

Card Group 1: 1 Card NMNP (# of node points) (I10)

Card Group 2: NMNP Cards (2I5, 3F10.0)

(NEXT(I), NBC(NEXT(I)), X(NEXT(I), Y(NEXT(I)), DEPTH(NEXT(I)),
I = 1, NMNP)

Card Group 3: Land Boundary Data (8I10) One Card

NMLB, (NMLBN(I), I = 1, NMLB)

Card Group 4: Segment Connectivity (20I4)

(ICONL(I,J), J = 1, NMLBN(I))

NBAND

Upon entering of the number of nodes, the number of elements, the CAFE nodal data, and the element interconnectivity matrix, this program will reorder the nodes in such a way as to provide the lowest possible bandwidth for the element configuration.

Dimensioning:

Dimension Variables:

NMEL - number of elements

NMNP - number of node points

```
DIMENION ICON1(NMEL), ICON2(NMEL), ICON3(NMEL), ICON(3*NMEL),
MEMJT(8*NMNP), JMEM(NMNP), JNT(NMNP), NEWJT(NMNP), JOINT(NMNP),
JPO(NMNP), NEXT(NMNP), NBC(NMNP), X(NMNP), Y(NMNP), D(NMNP),
D1(NMNOP), D2(NMNP), D3(NMNP), D4(NMNP)
```

Input Data:

Card Group 1: NMNP, NMEL One Card (2I5)

Card Group 2: Nodal Information

Same as Card Group 3 in CAFE User's Manual

Card Group 3: Element Connectivity

Same as Card Group 4 in CAFE User's Manual

Program Output:

The program will output the nodal information in its reordered form, it will also output the bandwidth of the grid configuration.

QBCOMP

In CAFE, specified inflows to the system are given in units of meters^2-sec^{-1} (velocity x depth). QBCOMP will convert units of meters^3-sec^{-1} (discharge) into the CAFE units. (Note: This program is used most easily in interactive WATFIV, but can be run in batch if desired.)

Dimensioning:

NMNP - number of node points

NMLB - number of land boundaries

NMLBN - maximum number of nodes on any land boundary

```
DIMENION NEXT(NMNP), X(NMNP), Y(NMNP), Q(NMNP), IS(NMNP), JS(NMNP),
ICONL(NMLB, NMLBN), NMLBN(NMLB)
```

Input Data:

Card Group 1: NMNP — One Card (I5)

Card Group 2: Nodal Information

Same as Card Group 3 in CAFE User's Manual.

Card Group 3: Land Boundary Data

Same as Card Group 8 and 9 in CAFE User's Manual.

Card Group 4: NNODES — One Card (I5)

NNODES is the number of nodes for which inflow computation is desired.

Card Group 5: Inflow Data — NNODES Cards (I5, F10.2)

a) Node - external node number of node for which inflow computation is desired.

b) Q - specified inflow in meters^3-sec^{-1}.

MISCELLANY

Define File Statements - The define file statements in the main program (statement numbers 27, 28, and 32) must be modified to correspond to the direct-access files being read. (For an explanation of the define file statement, see "IBM System 360/370 FORTRAN IV Language, p. 72.) File 10 contains discharge information, File 11 contains heights, and File 12 has concentrations. The number of records, and the length of these records, should be specified as they were in the CAFE or DISPER run which generated the output to be plotted. If problems with reading the direct-access files are encountered, these statements are the first places to check.

Net Velocity Plots - When producing a net velocity plot (IVEL = 2), the "time information" card (Card Group 2c) should be coded:

NPLOTS = 2

NTIME(1) = NTIME at which velocity averaging is to start

NTIME(2) = NTIME at which velocity averaging is to stop

When plotting net velocities over one tidal cycle, care must be taken to ensure that NTIME(1) and NTIME(2) define exactly one tidal cycle. Since the magnitude of instantaneious velocities is generally much greater than the magnitude of the net velocities, and since the net velocities are generated by vector addition, omission of even a small part of a tidal cycle will lead to large errors in the plot.

Dimensioning - If dimensioning problems are encountered in one of the subroutines, check the dimension variable initialization in the block data subroutine.

- CAFGRAPH -

This program will graphically display the outputs generated by CAFE and DISPER. It will:

Plot element geometry with optional element numbering.

Plot element grid boundaries.

Plot velocity vectors generated by CAFE.

Generate and plot net velocities.

Plot concentrations generated by DISPER.

Plot water surface elevations generated by DISPER.

The nodal coordinates may be any real value; the grid will be drawn properly located with respect to a pair of labeled x and y axes. The line thicknesses of the elements, grid boundaries, and velocity vectors are user-specified options. Inputs for velocity, water surface elevation, and concentration are taken from the direct access files generated by CAFE or DISPER.

NOTE: All references to the CAFE User's Manual refer to Wang's version.

Dimensioning

Dimension Variables:

NMNP - number of node points

NMEL - number of elements

NMLB - number of land boundaries

NMLBN - maximum number of nodes on any land boundary

NMOB - number of ocean boundaries

NMOBN - maximum number of nodes on any ocean boundary

NPLOTS - number of plots in a time sequence (see card group 2)

Dimension Statement: (M/PROG)

```
DIMENSION NEXT (NMNP), NINT(NMNP), X(NMNP), Y(NMNP), NELM(NMEL),
ICON(NMEL, 3), XC(NMEL), YC(NMEL), NMLBN(NMLB), ICONL(NMLB, NMLBN),
NMOBN(NMOB), ICONO(NMOB, NMOBN), C(NMNP), ARRAY(NMNP), U(NMNP), V(NMNP),
H(NMNP),Q(NMNP*2), A(3), TITLE(14), XT(18), YT(18), NTIME(NPLOTS),
BS(10), D(NMNP)
```

Program Inputs

Card Group 1: Options   One Card (7I2)

a) IELM = 0 - no plot of element geometry

1 - produces plot of element geometry

2 - element geometry with numbered elements

b) IBOUND = 0 - no plot of land or ocean boundaries

1 - plots land and ocean boundaries

c) IVEL = 0 - no plot of velocities

1 - produces plot of velocity field generated by CAFE

2 - produces plot of net velocity field (averaged from NTIME(1) to NTIME(2))

d) ICONC = 0 - no concentration plot

1 - produces a plot of element concentrations generated by DISPER

e) IETA = 0 - no plot of water surface elevation

1 - produces a plot of water surface elevation above MLW

f) IOUTPUT= 0 - no listing of input data

1 - produces a listing of input data in the printed output data set

g) NCOPY = Enter the number of copies of each plot desired. If only one copy is desired, this may be left blank.

Card Group 2 Sequenced Plot Data: (Use Card Group 2 only if IVEL + ICONC + IETA > 0)

2a) Title (14A4) enter a title of up to 56 characters. The front should be padded with blanks as necessary to center the text in the 56 spaces.

2b) BS (10A4) this is another space for entering notes in the title block. This space is useful for recording the data set name(s) of the disk(s) being used.

2c) Time Information (2015)

NPLOTS, (NTIME(I), I = 1,NPLOTS)

Where each NTIME(I) is a fortran direct-access record number for which a plot is desired, and NPLOTS is the number of these.

Card Group 3: Scale Parameters One Card (4F10.2)

a) GSCALE - scale of plot (GSCALE units/inch of plot)

b) VSCALE - scale of velocity vectors

c) CFACT - concentrations to be plotted will be multiplied by this factor to aid in plot interpretation

d) TSC - scale factor for title block. This is useful when producing plots which will be reduced. TSC = 1.0 yields a title block 4.0" x 1.6". TSC > 1.0 yields a proportionately large title block.

Card Group 4: Lineweights One Card (4I5)

An explanation of allowable values for the line weight parameters can be found in the Gould Plot Package Programming Manual, Sec. 2.4.

a) LW1 - element geometry

b) LW2 - land boundaries

c) LW3 - ocean boundaries

d) LW4 - velocity vector arrows

Card Group 5: NMEL, NMNP One Card (2I5)

a) NMEL - number of elements

b) NMNP - number of node points

Card Group 6: Nodal Coordinates

This is the same as "Card Group 3" in the CAFE User's Manual.

Card Group 7: Element Data

This is the same as "Card Group 4" in the CAFE User's Manual.

Card Group 8: Land Boundary Data

Card Group 9: Segment Connectivity

Card Group 10: Ocean Boundary Data

Card Group 11: Segment Connectivity

Card Groups 8-11 are identical to Card Groups 7-10 in the CAFE Users's Manual. If IBOUND = 0, these cards may be omitted.

```
//$CAFE JOB(1066,0806,1000,25,0),'CAROL CONNER',CLASS=1,REGION=500K
/*PASSWORD     001,NINE
/*ROUTE PRINT LOCAL
// EXEC FORTXCG,OPTIONS='OPT=2',LPARM='SIZE=500K'
//FORT.SYSIN DD *
/*INCLUDE SSPACES 10060606,2
/*INCLUDE CAFE2 10060606,3
/*INCLUDE CAFE3 10060006,3
/*INCLUDE CAFE4 10060806,3
//GO.SYSIN DD *
    1  439  281    1    1    2    2    2    2    2 2136    1    0    1    1   91
APALACHICOLA BAY GRID #6  - HALF TIDE CURVE RUN -  CDC
/*INCLUDE NODE6 10060806,3
/*INCLUDE ELEM6 10060606,4
      29.  .72722E-4      9.81     44640.      1025.
        0.   216000.       60.       270         3.          1        200         11
/*INCLUDE BOUND6 10060806,4
/*INCLUDE BNDELM6 10060906,3
     2.24       207.
       10       1464       562          1         11       1464        281          1
/*INCLUDE HTIDE6C 10060806,2
/*INCLUDE WETA6 10060806,1
    0
//GO.FT09F001 DD SYSOUT=A
//GO.FT10F001 DD DSN=UF.A0060806.HTCCR,
// UNIT=SYSDA,SPACE=(TRK,(53,2),RLSE),
// DISP=(,CATLG),DCB=(DSORG=DA)
//GO.FT11F001 DD DSN=UF.A0060806.HTCCN,
// UNIT=SYSDA,SPACE=(TRK,(26,2),RLSE),
// DISP=(,CATLG),DCB=(DSORG=DA)
```

```
//DISPER JOB (1006,0806,3500,50,0),'APALACHICOLA BAY',CLASS=1
/*PASSWORD     001,NINE
/*ROUTE PRINT LOCAL
// EXEC FORTXCG,OPTIONS='OPT=2'
//FORT.SYSIN DD *
/*INCLUDE DISDIM6 10060806,2
/*INCLUDE DISPERA 10060806,3
/*INCLUDE DISPER2 10060806,3
//GO.SYSIN DD *
                  GRID #6 - CONSTANT NODE CONCENTRATIONS, NEW FCONS
       439       281         0         23         0         0         0
/*INCLUDE NODE6 10060806,3
/*INCLUDE ELEM6 10060806,4
/*INCLUDE DISBND6 10060806,4
/*INCLUDE HGNODEF 10060806,4
0.0        691200.   180.0          10   0.001     60   1    3    2    1
1500.00    1500.00   0.0E01
/*INCLUDE HOTCON6 10060806,3
-1.0
//GO.FT09F001 DD SYSOUT=A
//GO.FT10F001 DD DSN=UF.A0060806.HTCAQ,
// DISP=(OLD,KEEP)
//GO.FT11F001 DD DSN=UF.A0060806.HTCAH,
// DISP=(OLD,KEEP)
//GO.FT12F001 DD DSN=UF.A0060806.CONC85,
// UNIT=SYSDA,SPACE=(TRK,(35,1),RLSE),
// DISP=(,CATLG),DCB=DSORG=DA
//GO.FT13F001 DD DUMMY
```

```
//CAFGRAF JOB (1006,0809,40,2.0),'ANN CONWAY',CLASS=A
/*PASSWORD     001,NINE
/*ROUTE PRINT TCP
// EXEC FORTGCG,PLOT=
//FORT.SYSPRINT DD DUMMY
//FORT.SYSIN DD *
/*INCLUDE GRAFFORT
//GO.SYSIN DD *
 0 1 0 1 0 0 1


    1   91
     5800          .5         1.        0.6
    0   -1    2    0
  439  281
/*INCLUDE NODE6 10060809,1
/*INCLUDE ELEM6 10060809,1
/*INCLUDE BOUND6 10060809,3
/*INCLUDE CONC1
//GO.FT10F001 DD DSN=UF.A0060809.HTCAQ,
// DISP=(OLD,KEEP)
//GO.FT11F001 DD DSN=UF.A0060809.HTCAH,
// DISP=(OLD,KEEP)
//GO.FT12F001 DD DSN=UF.A0060809.CONC1,
// DISP=(OLD,KEEP)
//GO.FT13F001 DD DUMMY
// EXEC PLOT
```

FILE MAP OF VOLUME LFLA01

FILE NUMBER	DATA SET NAME	RECORD FORMAT	BLOCK LENGTH	RECORD LENGTH	BLOCK COUNT	DENSITY	TAPE RECORDING TECHNIQUE	CREATION DATE	EXPIRATION DATE
1	BOUNDELM	FB	6,160	80	2	6250-BPI		12/10/81	
2	NBAND	FB	6,160	80	2	6250-BPI		12/10/81	
3	QBANG	FB	6,160	80	1	6250-BPI		12/10/81	
4	QBCOMP	FB	6,160	80	6	6250-BPI		12/10/81	
5	$SPACES	FB	6,160	80	1	6250-BPI		12/10/81	
6	CAFE2	FB	6,160	80	6	6250-BPI		12/10/81	
7	CAFE3	FB	6,160	80	6	6250-BPI		12/10/81	
8	CAFE4	FB	6,160	80	6	6250-BPI		12/10/81	
9	DISDIM6	FB	6,160	80	1	6250-BPI		12/10/81	
10	DISPERA	FB	6,160	80	6	6250-BPI		12/10/81	
11	DISPER2	FB	6,160	80	6	6250-BPI		12/10/81	
12	GRAFFORT	FB	6,160	80	5	6250-BPI		12/10/81	

END OF VOLUME ENCOUNTERED.