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 $c_0 = 0$ 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 $c_0$-values and for determination of the vertically averaged salinity $s$ from the salinity $s_0$ 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 $c_0 = 0$ 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: $t = 0 \times \frac{1}{8}$
Length Scale: 1 in = 6400 m
Velocity Scale: 1 in = 1 m s$^{-1}$

JAN 1
Indicated concentrations \( c \) correspond to \( c_R = 100 \) and \( c_0 = 0 \).

Concentrations \( c_1 \) corresponding to \( c_R = c_R \div 100 \) and \( c_0 = c_R \div 0 \) are found from

\[
c_1 = c \frac{c_R - c_0}{100} + c_0
\]

Salinities \( s \) are found from

\[
s = (1 - \frac{c}{100}) s_0
\]

where \( s_0 \) = salinity at passes connecting to the Mexican Gulf.
Indicated concentrations $c$ correspond to $c_R = 100$ and $c_0 = 0$.

Concentrations $c_1$ corresponding to $c_R = c_R \div 100$ and $c_0 = c_0 \div 0$ are found from

$$c_1 = c \frac{c_R - c_0}{100} + c_0$$

Salinities $s$ are found from

$$s = (1 - \frac{c}{100}) s_0$$

where $s_0 = $ salinity at passes connecting to the Mexican Gulf.

APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_0 = 0$

Time After: $t = 1 \times \frac{T}{8}$
Low Tide:
Length Scale: $1$ in $= 5800$ m
Indicated concentrations \( c \) correspond to \( c_R = 100 \) and \( c_O = 0 \).

Concentrations \( c_1 \) corresponding to \( c_R = c_R + 100 \) and \( c_O = c_O + 0 \) 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
Indicated concentrations correspond to \( c_R = 100 \) and \( c_0 = 0 \).

Concentrations \( c_1 \) corresponding to \( c_R = c_R \) and \( c_0 = c_0 \) are found from

\[
c_1 = c \frac{c_R - c_0}{100} + c_0
\]

Salinities \( s \) are found from

\[
s = (1 - \frac{c}{100}) s_0
\]

where \( s_0 \) = salinity at passes connecting to the Mexican Gulf.

APALACHICOLA BAY
Franklin County, Florida

QUALITY MODEL
\( c_R = 100 \)
\( c_0 = 0 \)

Time After
Low Tide:
\[ t = 3 \times \frac{T}{8} \]
Length Scale: 1 in = 5800 m
Indicated concentrations \( c \) correspond to \( c_R = 100 \) and \( c_0 = 0 \).

Concentrations \( c_I \) corresponding to \( c_R = c_R \div 100 \) and \( c_0 = c_0 \div 0 \) are found from

\[
c_I = c = \frac{c_R - c_0}{100} + c_0
\]

Salinities \( s \) are found from

\[
s = (1 - \frac{c}{100}) s_0
\]

where \( s_0 \) = salinity at passes connecting to the Mexican Gulf.

APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
\( c_R = 100 \)
\( c_0 = 0 \)

Time After \( t = 4 \times \frac{T}{8} \)
Low Tide:
Length Scale: 1 in = 5800 m
Indicated concentrations $c$ correspond to $c_R = 100$ and $c_0 = 0$.

Concentrations $c_1$ corresponding to $c_R = c_R \div 100$ and $c_0 = c_0 \div 0$ are found from

$$c_1 = c \frac{c_R - c_0}{100} + c_0$$

Salinities $s$ are found from

$$s = (1 - \frac{c}{100}) s_0$$

where $s_0 = \text{salinity at passes connecting to the Mexican Gulf.}$

---

APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_0 = 0$

Time After
Low Tide: $t = 5 \times \frac{1}{8}$

Length Scale: 1 in = 5800 m

JAN 15
Indicated concentrations $c$ correspond to $c_R = 100$ and $c_0 = 0$.

Concentrations $c_1$ corresponding to $c_R = c_R \div 100$ and $c_0 = c_0 \div 0$ are found from

$$c_1 = c \frac{c_R - c_0}{100} + c_0$$

Salinities $s$ are found from

$$s = (1 - \frac{c}{100}) s_0$$

where $s_0$ = salinity at passes connecting to the Mexican Gulf.

APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_0 = 0$

Time After $t = 6 \times T$
Low Tide:
Length Scale: 1 in = 5800 m
Indicated concentrations $c$ correspond to $c_R = 100$ and $c_0 = 0$. 

Concentrations $c_1$ corresponding to $c_R = c_R + 100$ and $c_0 = c_0 + 0$ are found from 

$$c_1 = \frac{c_R - c_0}{100} + c_0$$

Salinities $s$ are found from 

$$s = (1 - \frac{c_0}{100}) s_0$$

where $s_0$ = salinity at passes connecting to the Mexican Gulf.

---

**APALACHICOLA BAY**

Franklin County, Florida

QUALITY MODEL

$c_R = 100$

$c_0 = 0$

Time After Low Tide: \( t = 7 \times \frac{T}{8} \)

Length Scale: 1 in = 5800 m

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: \( t = 3 \times \frac{T}{8} \)
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

<table>
<thead>
<tr>
<th>Time After Low Tide:</th>
<th>$t = 7 \times \frac{T}{8}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length Scale:</td>
<td>1 in = 6400 m</td>
</tr>
<tr>
<td>Velocity Scale:</td>
<td>1 in = 1 m s$^{-1}$</td>
</tr>
</tbody>
</table>

FEB 8
Indicated concentrations \( c \) correspond to \( c_R = 100 \) and \( c_O = 0 \).

Concentrations \( c_1 \) corresponding to \( c_R = c_R \times \frac{1}{100} \) and \( c_O = c_O \times 0 \) are found from

\[
c_1 = c \frac{c_R - c_O}{100} + c_O
\]

Salinities \( s \) are found from

\[
s = (1 - \frac{c}{100}) s_0
\]

where \( s_0 \) = salinity at passes connecting to the Mexican Gulf.

**APALACHICOLA BAY**
Franklin County, Florida

**QUALITY MODEL**

\[
\begin{align*}
c_R & = 100 \\
c_O & = 0
\end{align*}
\]

Time After Low Tide: \( t = 0 \times \frac{T}{8} \)

Length Scale: 1 in = 5800 m

FEB 10
Indicated concentrations $c$ correspond to $c_R = 100$ and $c_0 = 0$.

Concentrations $c_1$ corresponding to $c_R = c_R / 100$ and $c_0 = c_0 / 0$ are found from

$$c_1 = c - \frac{c_R - c_0}{100} + c_0$$

Salinities $s$ are found from

$$s = (1 - \frac{c}{100}) s_0$$

where $s_0$ = salinity at passes connecting to the Mexican Gulf.

---

APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_0 = 0$

Time After $t = 1 \times \frac{T}{8}$
Low Tide
Length Scale: 1 in = 5800 m

FEB 11
Indicated concentrations $c$ correspond to $c_R = 100$ and $c_O = 0$.

Concentrations $c_1$ corresponding to $c_R = c_R \div 100$ and $c_O = c_O \div 0$ 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

FEB 12
Indicated concentrations \( c \) correspond to \( c_R = 100 \) and \( c_o = 0 \).

Concentrations \( c_1 \) corresponding to \( c_R = c_R \div 100 \) and \( c_o = c_o \div 0 \) are found from:

\[
c_1 = c \left( \frac{c_R - c_o}{100} + c_o \right)
\]

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

\[
\begin{align*}
  c_R &= 100 \\
  c_o &= 0
\end{align*}
\]

Time After Low Tide:
\[
t = 3 \times \frac{T}{8}
\]

Length Scale: 1 in = 5800 m

FEB 13
Indicated concentrations $c$ correspond to $c_R = 100$ and $c_O = 0$.

Concentrations $c_1$ corresponding to $c_R = c_R \times 100$ and $c_O = c_O \times 0$ are found from

$$c_1 = c \left( \frac{c_R - c_O}{100} + c_O \right)$$

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

FEB 14
Indicated concentrations \( c \) correspond to \( c_R = 100 \) and \( c_0 = 0 \).

Concentrations \( c_1 \) corresponding to \( c_R = c_R + 100 \) and \( c_0 = c_0 + 0 \) are found from

\[
c_1 = c \frac{c_R - c_0}{100} + c_0
\]

Salinities \( s \) are found from

\[
s = (1 - \frac{c}{100}) s_0
\]

where \( s_0 \) = salinity at passes connecting to the Mexican Gulf.

APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
\( c_R = 100 \)
\( c_0 = 0 \)

Time After \( t = 5 \times \frac{T}{8} \)
Low Tide:

Length Scale: 1 in = 5800 m

FEB 15
Indicated concentrations $c$ correspond to $c_R = 100$ and $c_o = 0$.

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

$$c_1 = c \left( \frac{c_R - c_o}{100} + c_o \right)$$

Salinities $s$ are found from

$$s = (1 - \frac{c}{100}) s_0$$

where $s_0 =$ 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

FEB 16
Indicated concentrations $c$ correspond to $c_R = 100$ and $c_0 = 0$.

Concentrations $c_1$ corresponding to $c_R = c_R \div 100$ and $c_0 = c_0 \div 0$ are found from

$$c_1 = c - \frac{c_R - c_0}{100} + c_0$$

Salinities $s$ are found from

$$s = (1 - \frac{c}{100}) s_0$$

where $s_0$ = salinity at passes connecting to the Mexican Gulf.

---

APALACHICOLA BAY
Franklin County, Florida

QUALITY MODEL

$c_R = 100$
$c_0 = 0$

Time After $t = 7 \times \frac{1}{8}$
Low Tide:
Length Scale: 1 in = 5800 m

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 \( c_0 = 0 \) at all inlets to bay. Concentrations given at time increments equal to one eighth of the tidal period beginning at low tide.
Indicated concentrations $c$ correspond to $c_R = 100$ and $c_0 = 0$.

Concentrations $c_1$ corresponding to $c_R = c_R \div 100$ and $c_0 = c_0 \div 0$ are found from

$$c_1 = \frac{c_R - c_0}{100} + c_0$$

Salinities $s$ are found from

$$s = \left(1 - \frac{c}{100}\right) s_0$$

where $s_0 =$ salinity at passes connecting to the Mexican Gulf.
Indicated concentrations $c$ correspond to $c_R = 100$ and $c_O = 0$.

Concentrations $c_1$ corresponding to $c_R = c_R/100$ and $c_O = c_O + 0$ are found from:

$$c_1 = c - \frac{c_O}{100} + c_O$$

Salinities $s$ are found from:

$$s = \left(1 - \frac{c}{100}\right) s_0$$

where $s_0 = \text{salinity at passes connecting to the Mexican Gulf.}$

**APALACHICOLA BAY**
Franklin County, Florida

QUALITY MODEL

$c_R = 100$
$c_O = 0$

Time After Low Tide: $t = 1 \times \frac{T}{\Delta}$

Length Scale: 1 in = 5800 m
Indicated concentrations \( c \) correspond to
\[ c_R = 100 \] and \( c_0 = 0 \).

Concentrations \( c_1 \) corresponding to
\[ c_R = c_R + 100 \] and \( c_0 = c_0 + 0 \) are found from
\[ c_1 = c \cdot \frac{c_R - c_0}{100} + c_0 \]

Salinities \( s \) are found from
\[ s = (1 - \frac{c}{100}) s_0 \]
where \( s_0 \) = salinity at passes connecting to the Mexican Gulf.

APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
\[ c_R = 100 \]
\[ c_0 = 0 \]

Time After
Low Tide:
\[ t = 2 \times \frac{T}{8} \]
Length Scale: 1 in = 5800 m

MAR 12
Indicated concentrations \( c \) correspond to \( c_R = 100 \) and \( c_0 = 0 \).

Concentrations \( c_1 \) corresponding to \( c_R = c_R + 100 \) and \( c_0 = c_0 + 0 \) are found from

\[
c_1 = c \frac{c_R - c_0}{100} + c_0
\]

Salinities \( s \) are found from

\[
s = (1 - \frac{c}{100}) s_0
\]

where \( s_0 \) = salinity at passes connecting to the Mexican Gulf.
Indicated concentrations $c$ correspond to $c_R = 100$ and $c_0 = 0$.

Concentrations $c_1$ corresponding to $c_R = c_R + 100$ and $c_0 = c_0 + 0$ are found from

$$c_1 = c - \frac{c_R - c_0}{100} + c_0$$

Salinities $s$ are found from

$$s = (1 - \frac{c}{100}) s_0$$

where $s_0$ = salinity at passes connecting to the Mexican Gulf.

APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_0 = 0$

Time After Low Tide:
$t = 4 \times \frac{T}{8}$

Length Scale: 1 in = 5800 m
Indicated concentrations $c$ correspond to $c_R = 100$ and $c_0 = 0$.

Concentrations $c_1$ corresponding to $c_R = c_R + 100$ and $c_0 = c_0 + 0$ are found from

$$c_1 = c \frac{c_R - c_0}{100} + c_0$$

Salinities $s$ are found from

$$s = (1 - \frac{c}{100}) s_0$$

where $s_0$ = salinity at passes connecting to the Mexican Gulf.

APALACHICOLA BAY
Franklin County, Florida
QUALITY MODEL
$c_R = 100$
$c_0 = 0$

Time After
Low Tide:
$t = 5 \times \frac{T}{8}$
Length Scale: 1 in = 5800 m
MAR 15
Indicated concentrations \( c \) correspond to \( c_R = 100 \) and \( c_O = 0 \).

Concentrations \( c_1 \) corresponding to \( c_R = c_R + 100 \) and \( c_O = c_O + 0 \) are found from

\[
c_1 = c \left( \frac{c_R - c_O}{100} + c_O \right)
\]

Salinities \( s \) are found from

\[
s = \left(1 - \frac{c}{100}\right) s_0
\]

where \( s_0 \) = 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

MAR 16
Indicated concentrations $c$ correspond to $c_R = 100$ and $c_0 = 0$.

Concentrations $c_1$ corresponding to $c_R = c_R \div 100$ and $c_0 = c_0 \div 0$ are found from

$$c_1 = c \frac{c_R - c_0}{100} + c_0$$

Salinities $s$ are found from

$$s = (1 - \frac{c}{100}) s_0$$

where $s_0$ = salinity at passes connecting to the Mexican Gulf.

---

**APALACHICOLA BAY**
Franklin County, Florida

**QUALITY MODEL**

- $c_R = 100$
- $c_0 = 0$

Time After Low Tide:

$$t = 7 \times \frac{T}{8}$$

Length Scale: 1 in = 5800 m

MAR 17