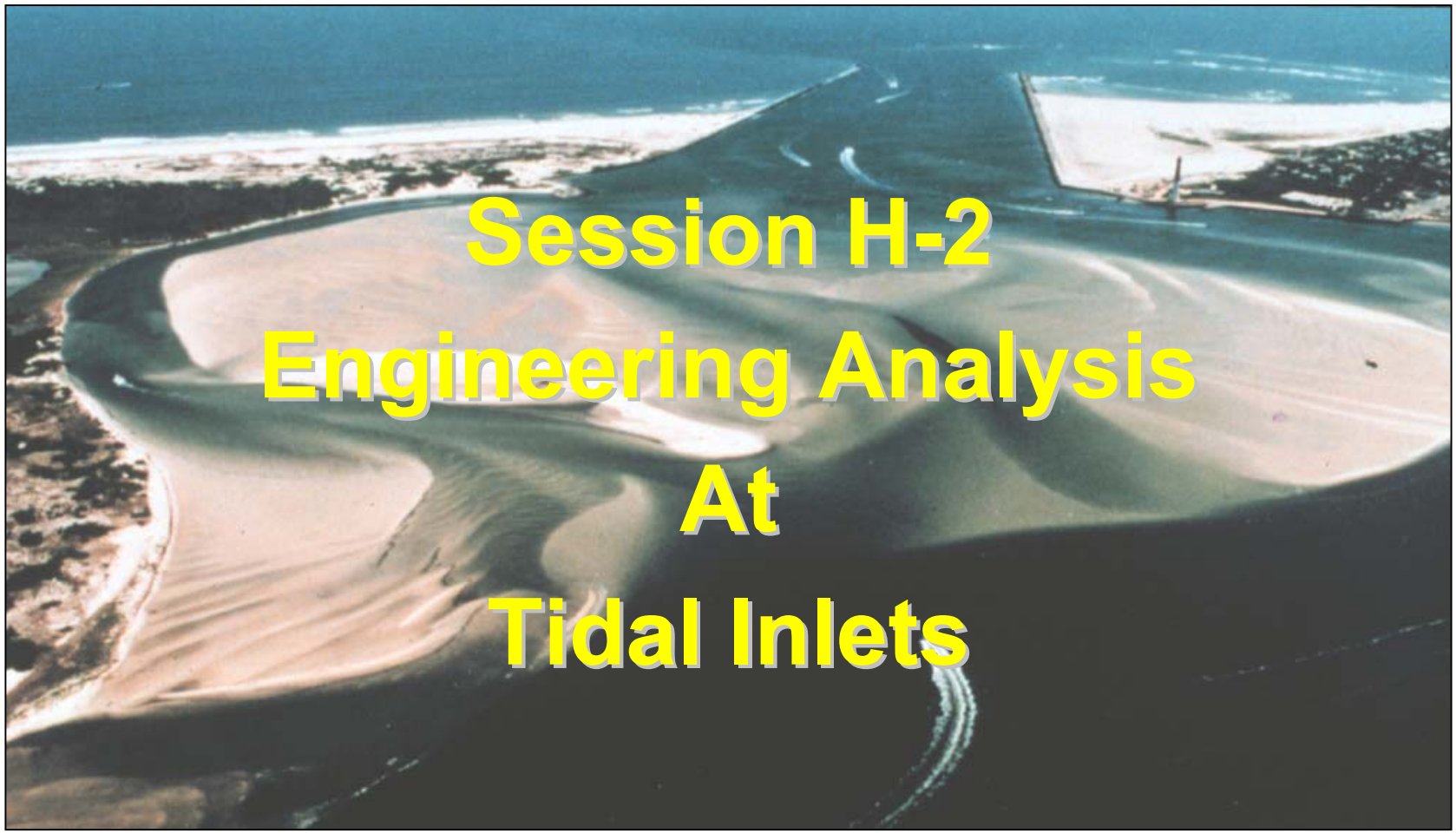
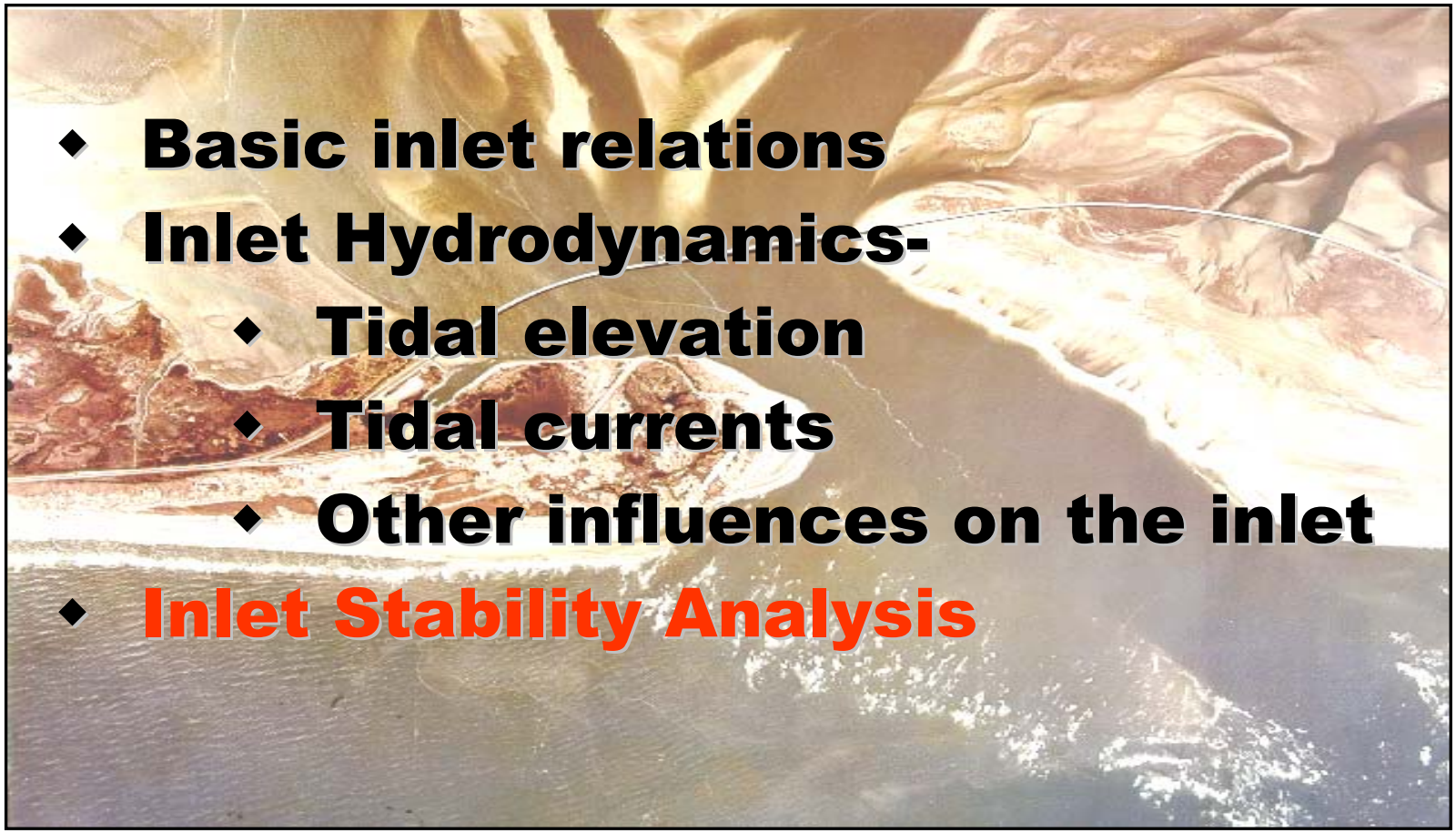
4th Annual Tech-transfer Workshop
Feb 10-12, 2003



Engineering Analysis At Tidal Inlets



- Basic inlet relations
- Inlet Hydrodynamics-
  - Tidal elevation
  - Tidal currents
  - Other influences on the inlet
- Inlet Stability Analysis

Coastal Inlet Stability
Why Study?

- New Inlet Design
  - Too much scour (Rollover Pass, Texas)
  - Will inlet close? (numerous locations)
- Change To Existing Inlet
  - Fill in part of bay
  - Change channel dimensions
  - Change channel length
  - Build jetties
  - Study extreme conditions

Wave and Tide (Current) Forces

Stable Inlets

- Ability of an inlet to maintain itself in a state of “stable equilibrium” against wave activity and associated littoral drift depends on availability of littoral sediment moving into the inlet and the tidal prism.

- Tidal Prism = Volume of water that is drawn into the bay from the ocean through the inlet during flood tide.

Channel Area - Tidal Prism Relationship

- A relation exists between minimum channel cross-sectional area, A_c (area below mean tide level) and tidal prism, P (during spring tide) (O'Brien,1931)

$$P = 5 * 10^4 A_c$$

Some Tidal Prism vs Minimum Inlet Flow Area Relationships

Table 1. Tidal Prism-Minimum Channel Cross-sectional Area Relationships

	Metric Units	American Customary Units
Atlantic Coast	$A_c = 3.039 \times 10^{-5} P^{1.05}$	$A_c = 7.75 \times 10^{-6} P^{1.05}$
Gulf Coast	$A_c = 9.311 \times 10^{-4} P^{0.84}$	$A_c = 5.02 \times 10^{-4} P^{0.84}$
Pacific Coast	$A_c = 2.833 \times 10^{-4} P^{0.91}$	$A_c = 1.19 \times 10^{-4} P^{0.91}$
Dual-Jettied Inlets (O'Brien)	$A_c = 7.489 \times 10^{-4} P^{0.86}$	$A_c = 3.76 \times 10^{-4} P^{0.86}$

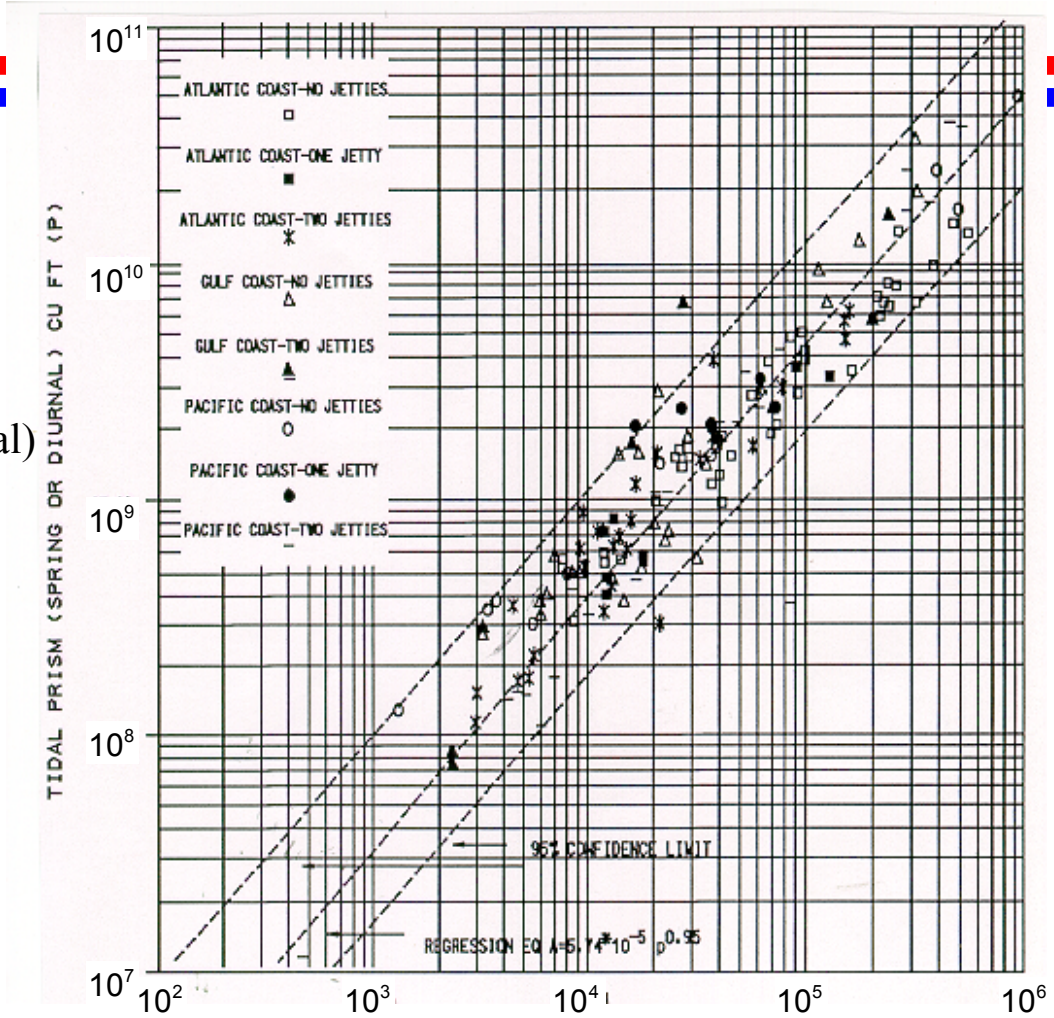
A_c is the minimum cross-sectional area in square meters (square feet), P is the tidal prism in cubic meters (cubic feet).

Derived from Jarrett, 1976

10^7

Tidal Prism Vs Channel Area

Tidal Prism
(Spring or Diurnal)
(Cubic ft)



Minimum Cross-sectional Area of Inlet (sq ft)

From Jarrett, 1976

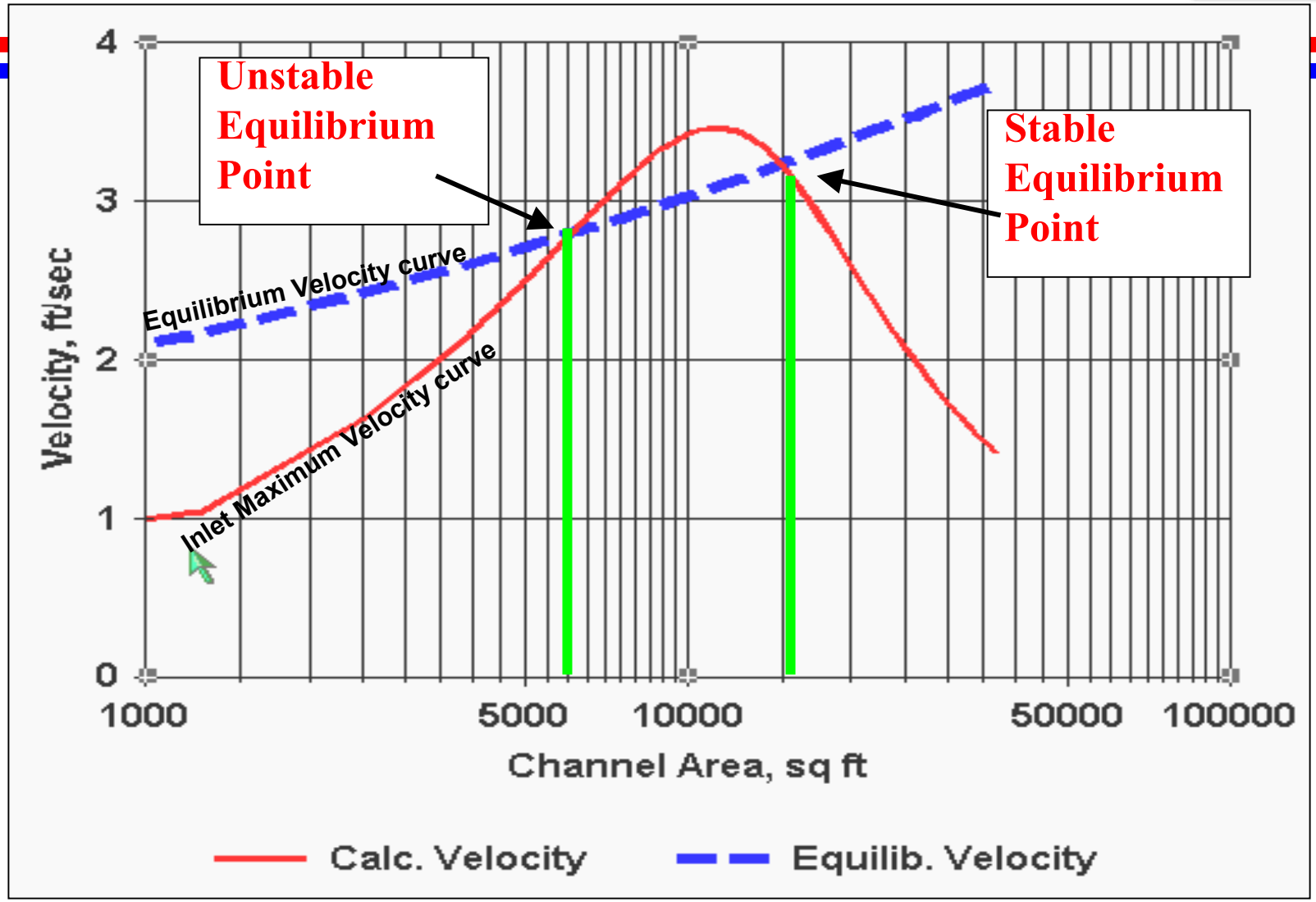
Natural Inlet Area Variation

- Inlet area can have a reasonable variation in magnitude (plus or minus 10%) over a short period of time.
  - Variation in tide range
  - Variation in wave activity
  - Storms
    - Infilling due to waves
    - Scour due to surge currents

Escoffier Method

- Escoffier method combines inlet hydraulics and inlet sedimentary results to see whether changes in an inlet cross-sectional area will result in hydraulic changes which will reverse or perpetuate the changes.

Escoffier Method



Derive the Equilibrium Velocity Vs Area Curve For Escoffier Diagram

Solve an equilibrium equation for P, e.g., Atlantic Coast relationship

$$P = \left(\frac{A_c}{7.75 \times 10^{-6}} \right)^{\left(\frac{1}{1.05} \right)}$$

And equate to an expression for tidal prism (found by integrating a sinusoidal discharge over flood or ebb)

$$P = \frac{T V_{\max} A_c}{\pi}$$

Equating and solving for $V_{\max}$

$$V_{\max} = \frac{\pi}{A_c T} \left(\frac{A_c}{7.75 \times 10^{-6}} \right)^{\frac{1}{1.05}}$$

Vary A_c and solve for $V_{\max}$

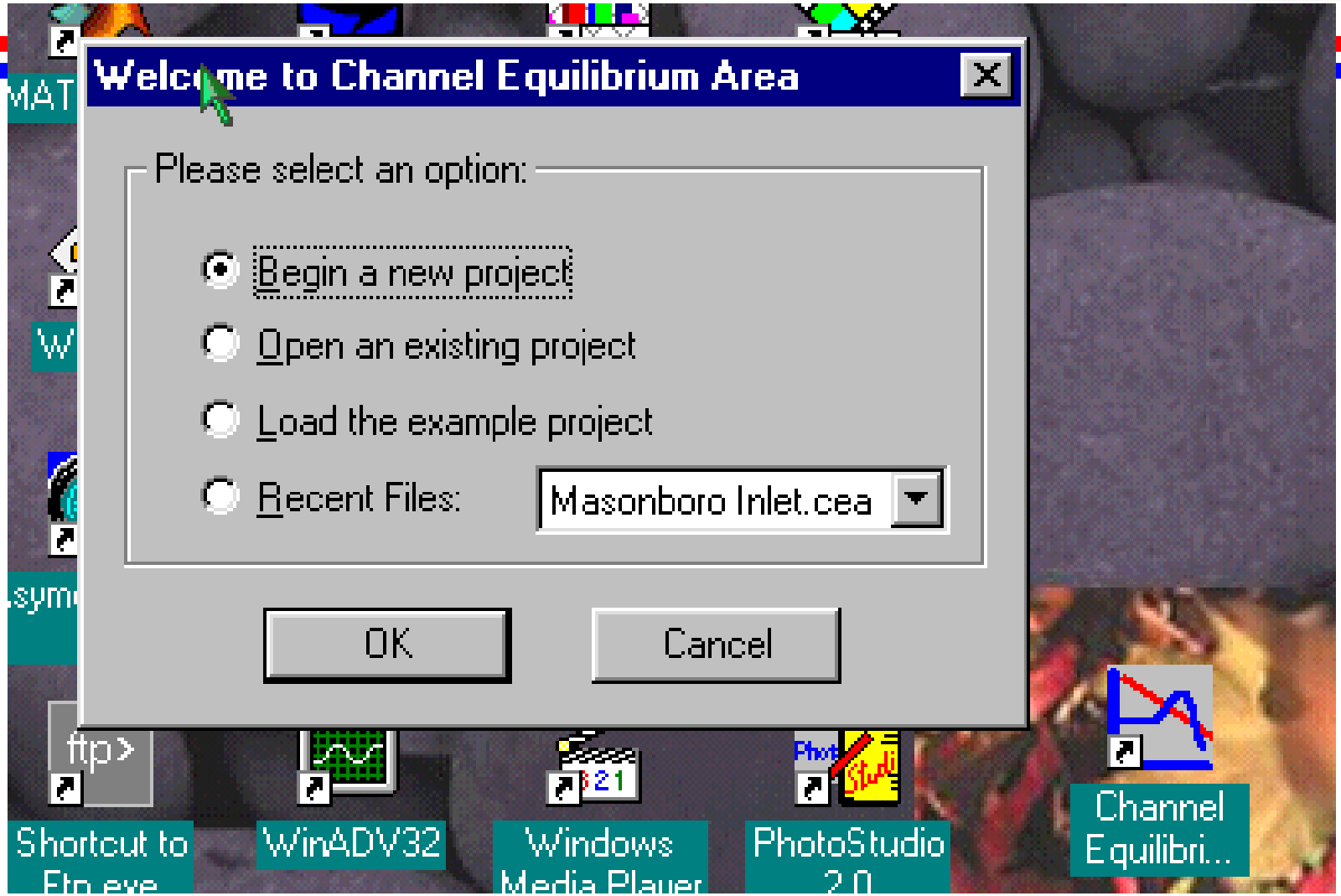
Calculate Inlet Maximum Velocity Vs Area Curve for the Escoffier Diagram

- The maximum velocity vs area curve for the specific inlet is developed from a simple 1-D model which is iterated over a range of channel areas holding other parameters constant, including tide range, channel length, bay surface area, friction parameters.

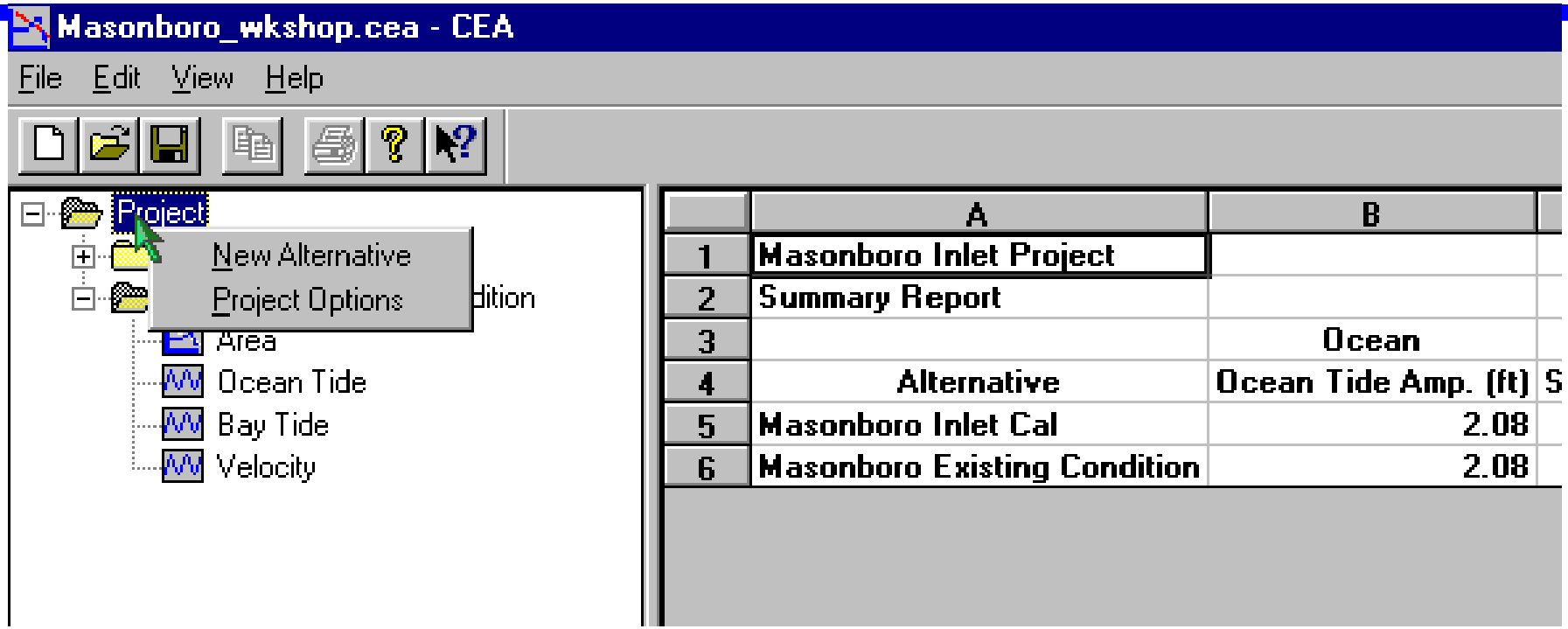
1-D Hydrodynamic Model

- Model of J.L. DiLorenzo, 1986
  - Analytical model
  - Includes M2 (principal lunar component) and M4 (overtide)
  - Determines maximum current, bay tide amplitude, and bay tide phase lag from ocean high water.
  - Includes inertial term, responds to Helmholtz (pumping) mode

PC Program - Channel Equilibrium Area

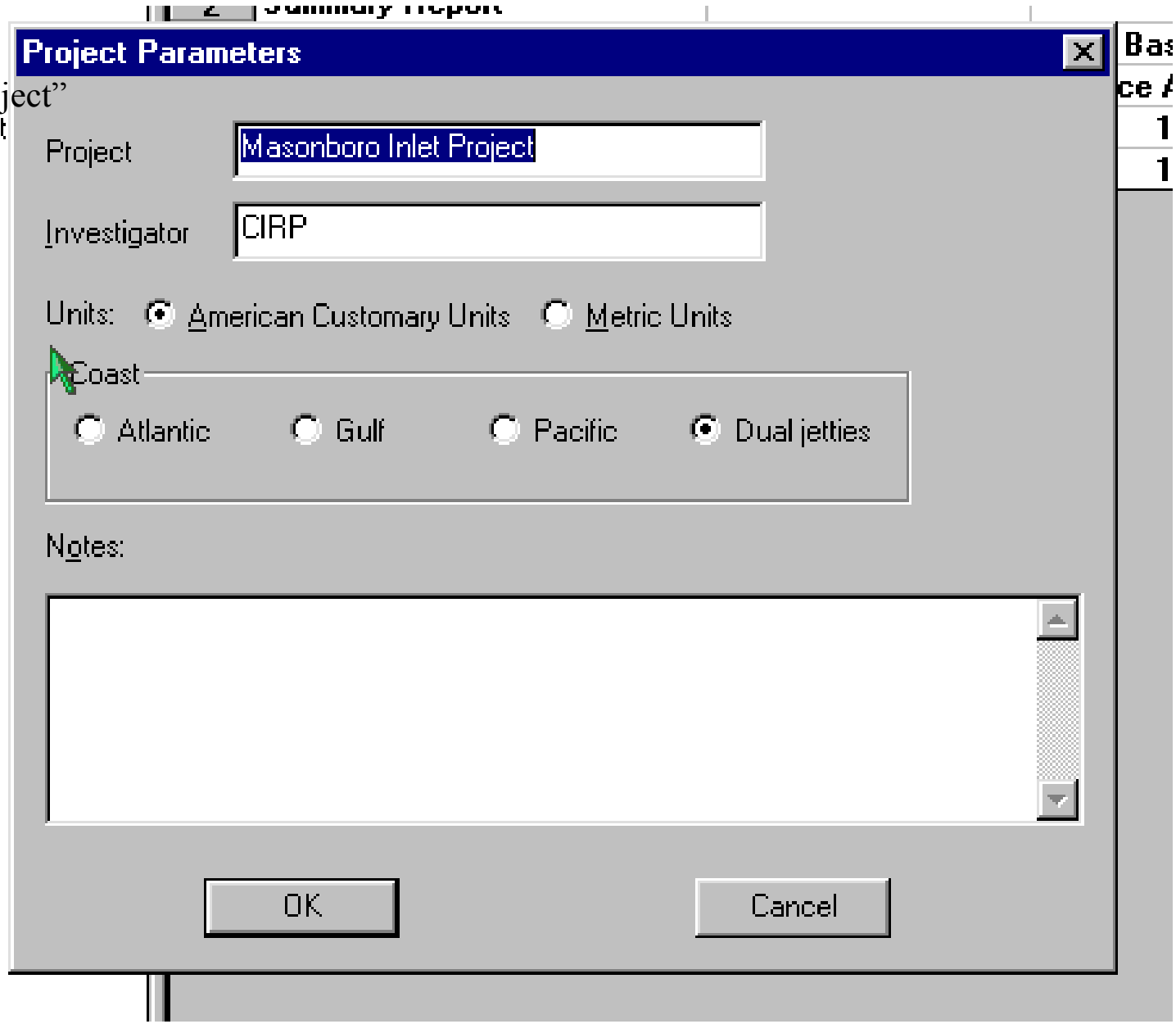


PC Program - Input Project Data

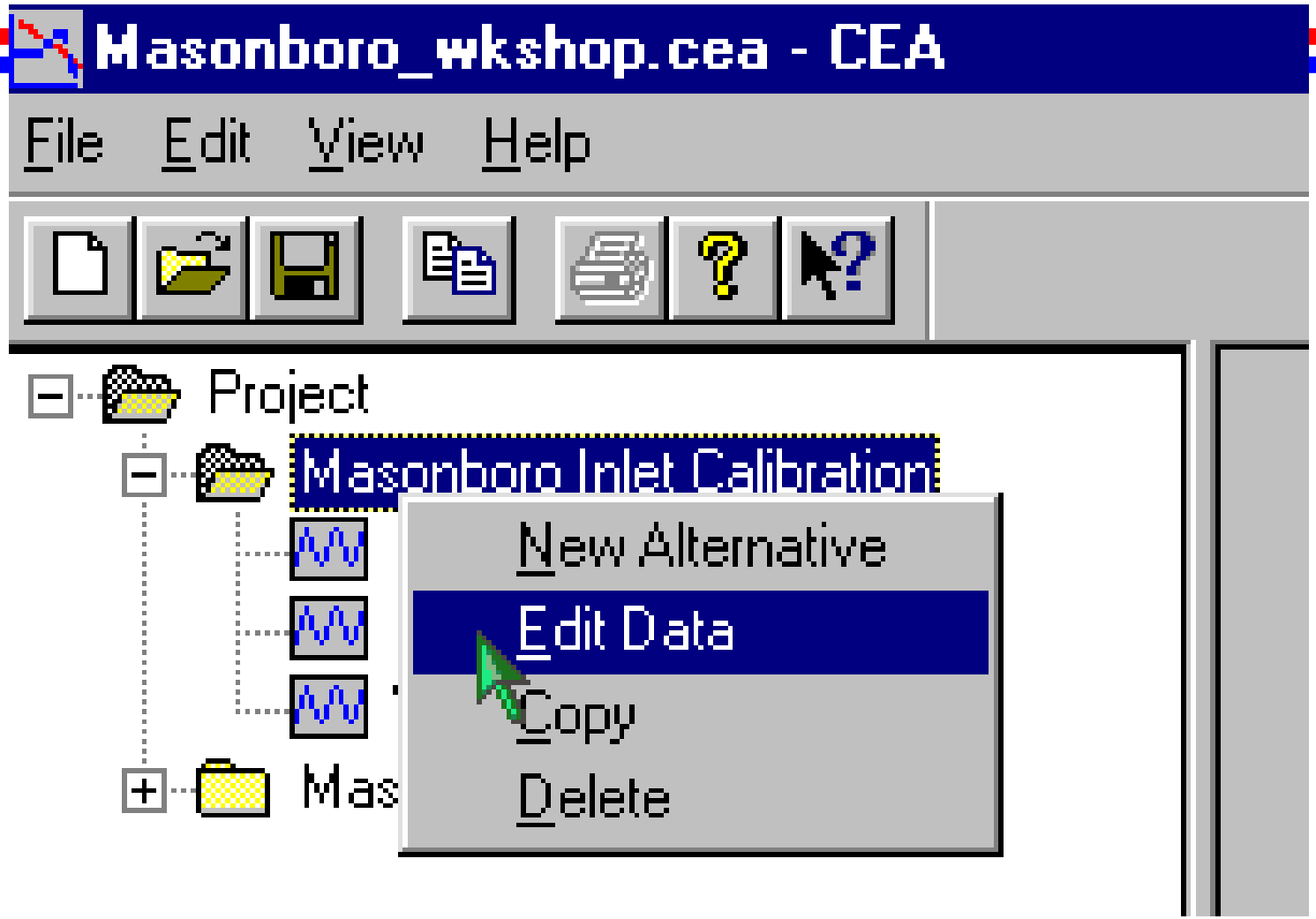


PC Program - Input Project Data

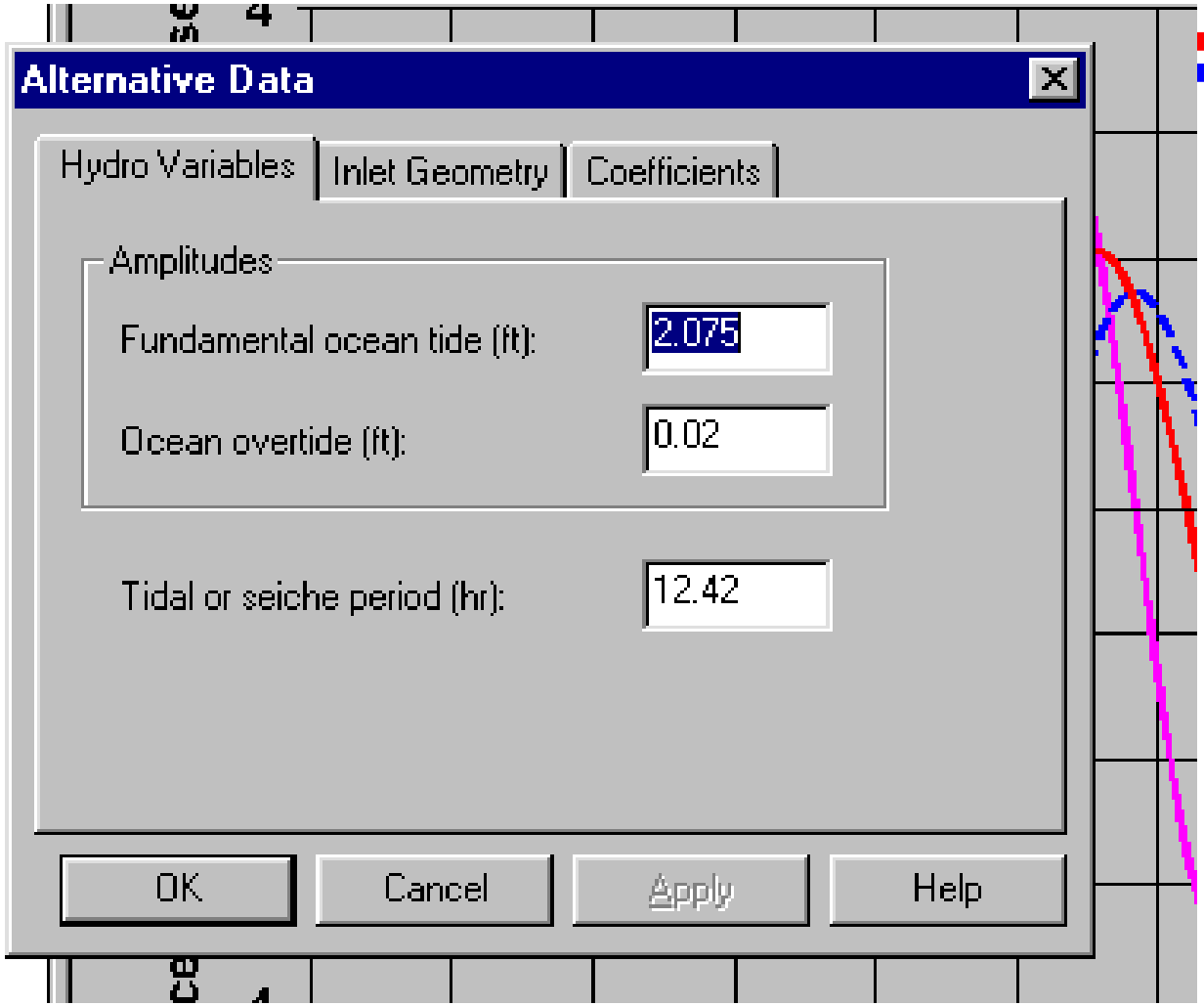
Right click "Project"



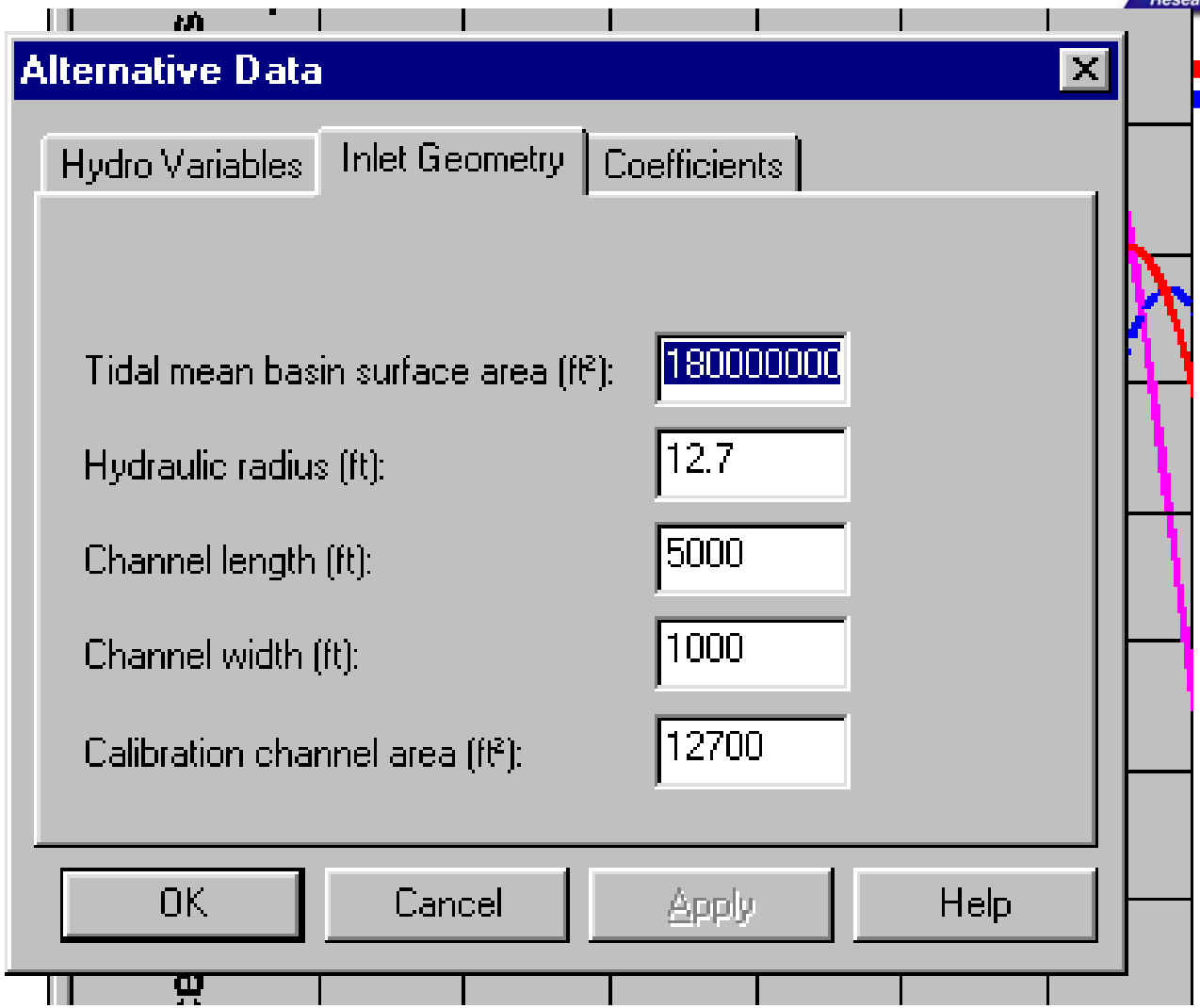
PC Model - Enter Hydro Variables



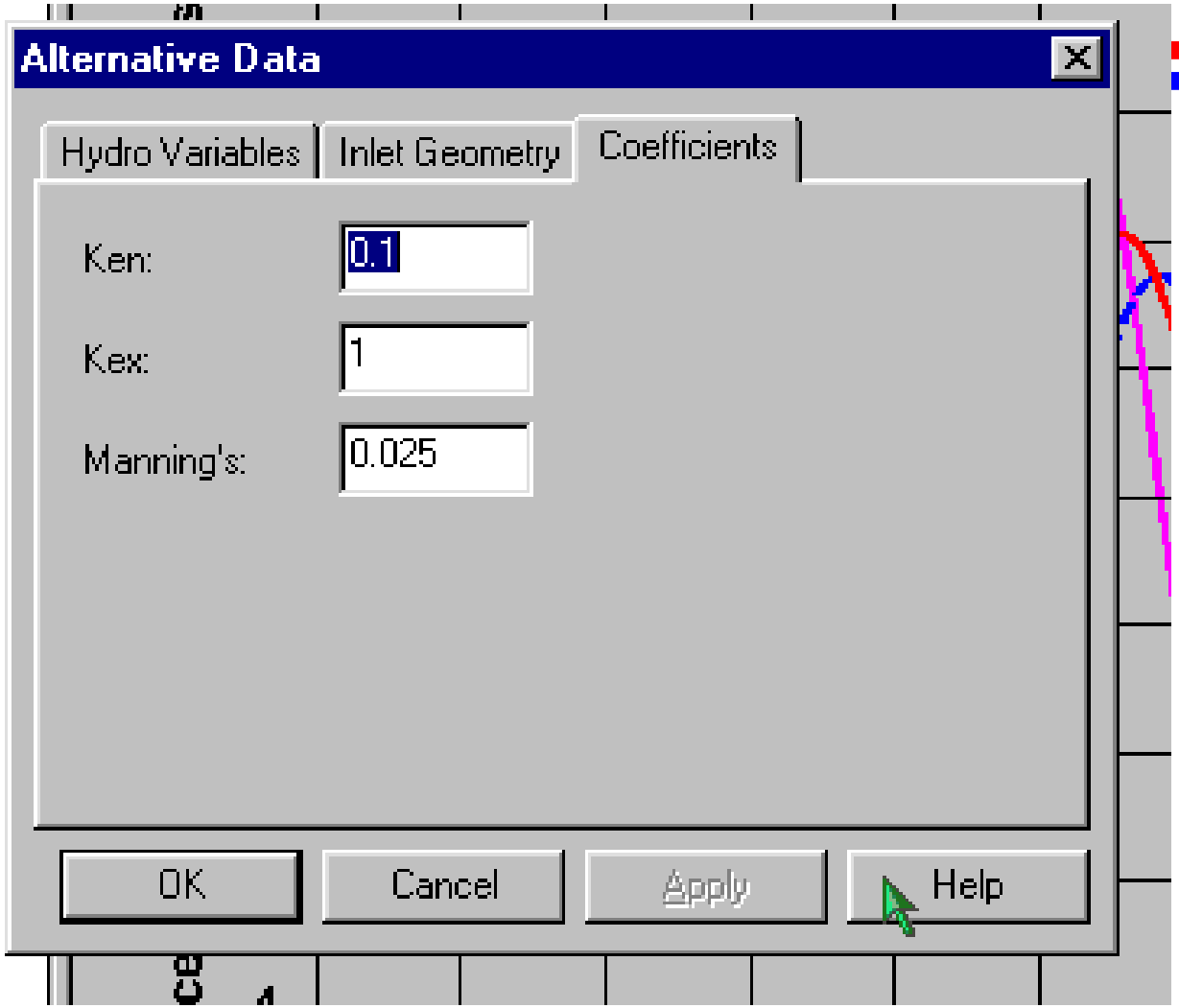
PC Program - Input "Hydro Variables"



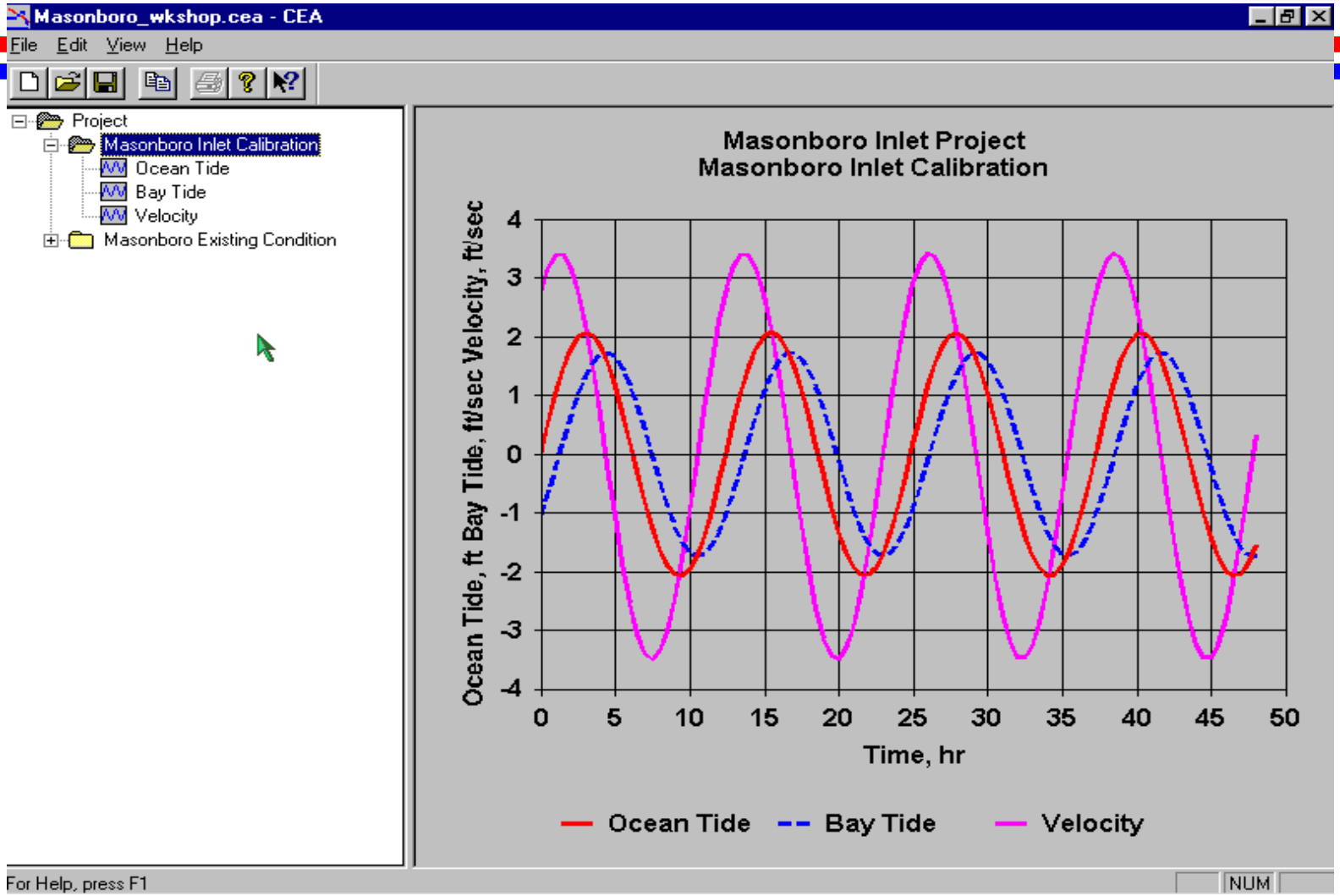
PC Program - Input "Inlet Geometry"



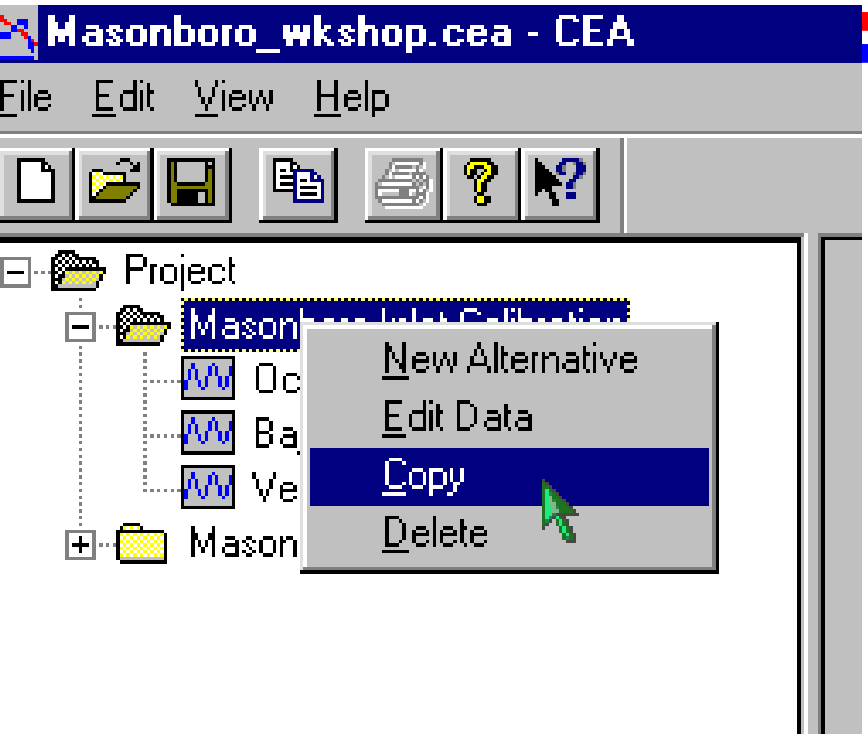
PC Program - Input “Coefficients”

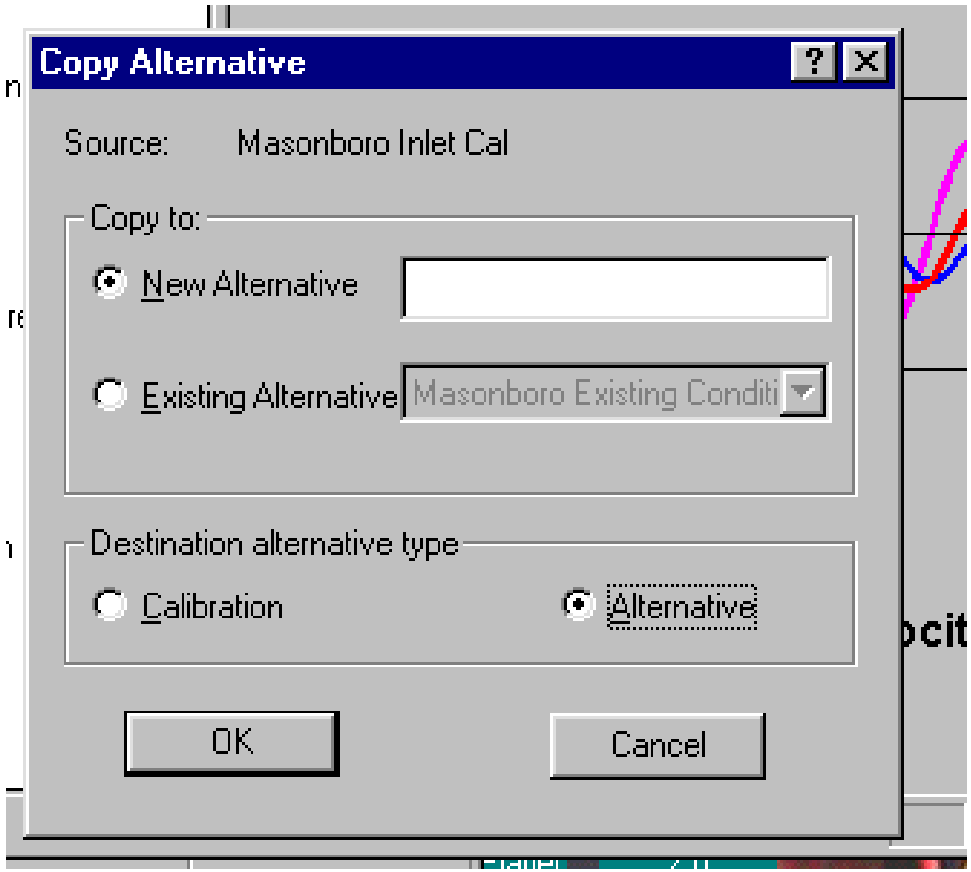


PC Program - Calibration



PC Program -After Calibration Copy Parameters To “New Alternative”

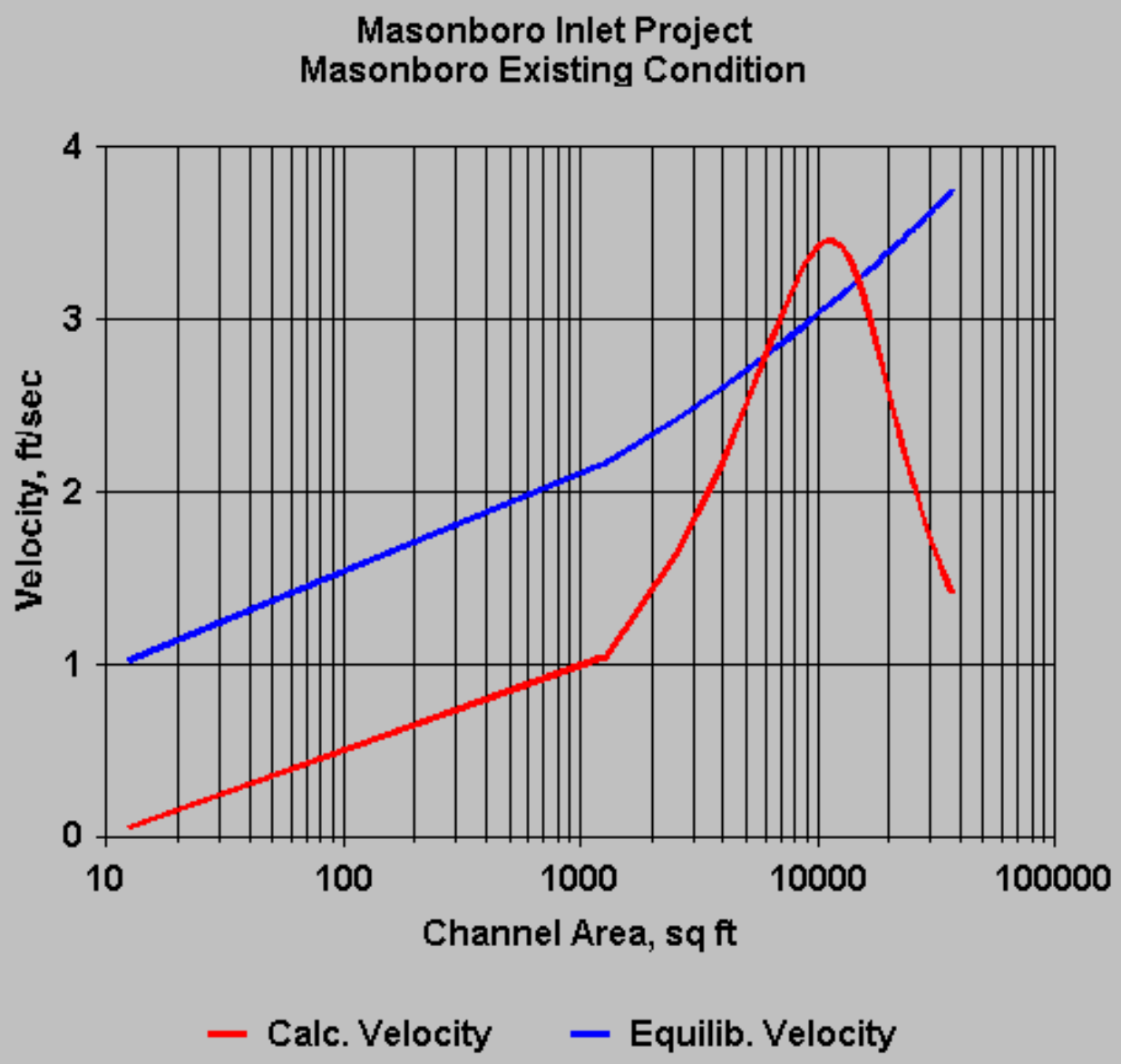




Masonboro_wkshop.cea - CEA

File Edit View Help

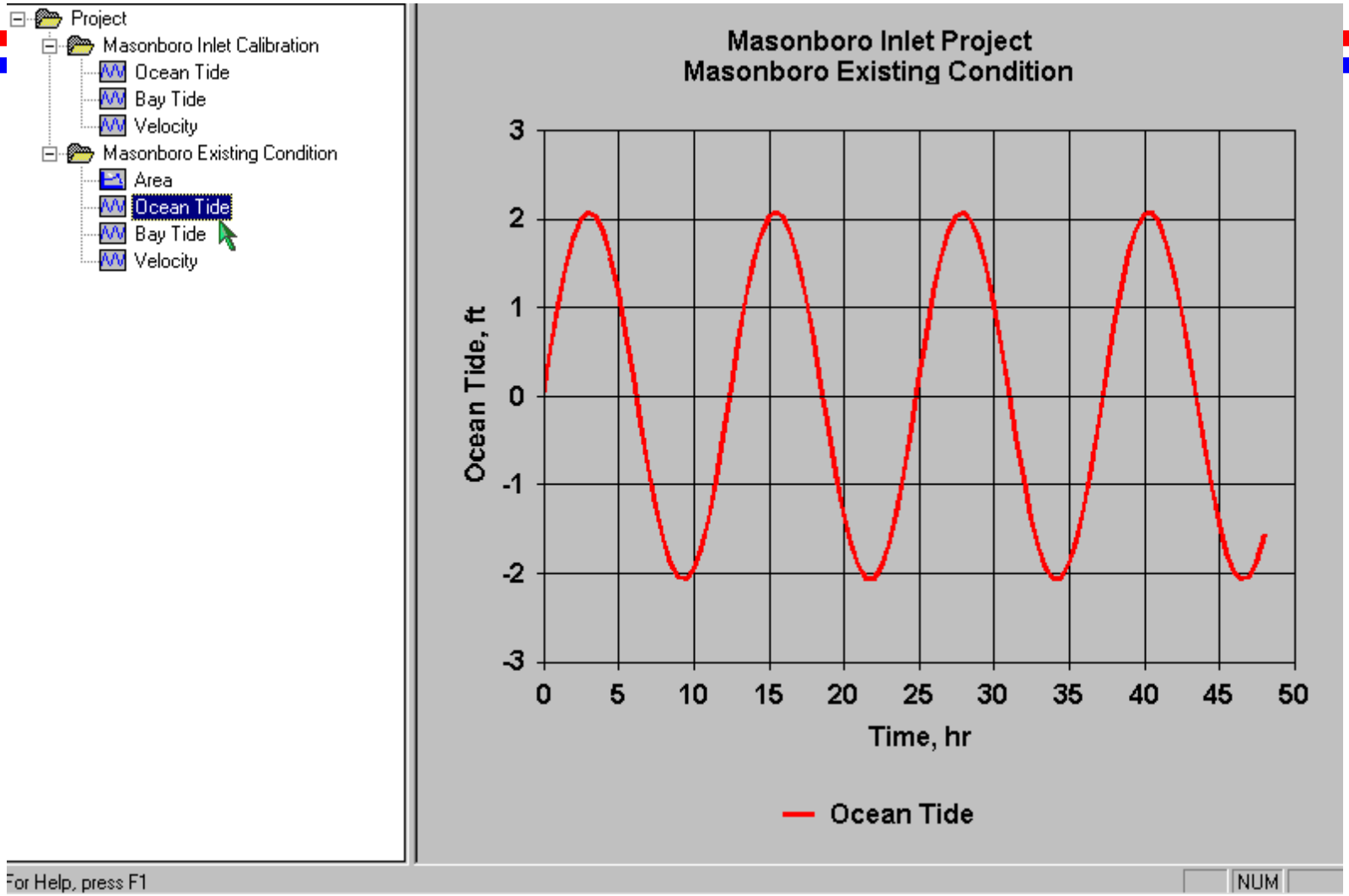
- Project
  - Masonboro Inlet Calibration
    - Ocean Tide
    - Bay Tide
    - Velocity
  - Masonboro Existing Condition
    - Area
    - Ocean Tide
    - Bay Tide
    - Velocity



For Help, press F1

NUM

PC Program -Plots of Tides and Currents Available



PC Program -Examine Summary Table

Masonboro Inlet.cea - CEA

File Edit View Help

Masonboro Inlet Project

Summary Report

Alternative	Ocean Tide Amp. (ft)	Ocean Overtide (ft)	Tidal Period (hr)	Channel Area (ft²)	Basin Surface Area (ft²)	Hydraulic Radius (ft)	Channel Length (ft)	Channel Width (ft)	Ken	Kex	n
Masonboro Inlet Cal	2.08	0.02	12.42	12700.00	180000000.00	12.70	5000.00	1000.00	0.10	1.00	0.025
Masonboro Existing Condition	2.08	0.02	12.42	12700.00	180000000.00	14.91	5000.00	1000.00	0.10	1.00	0.025
Reduce Surface Bay Area	2.08	0.02	12.42	12700.00	130000000.00	10.24	5000.00	1000.00	0.10	1.00	0.025
Reduce Channel Width	2.08	0.02	12.42	16000.00	180000000.00	31.97	5000.00	500.00	0.10	1.00	0.025

nel th	Ken	Kex	n	Baytide Amplitude (ft)	Channel Velocity (ft)	Equilibrium Area (ft²)
.00	0.10	1.00	0.025	0.84	3.14	12700.00
.00	0.10	1.00	0.025	0.93	3.33	14908.70
.00	0.10	1.00	0.025	0.83	3.04	10240.56
.00	0.10	1.00	0.025	1.01	3.58	15985.80