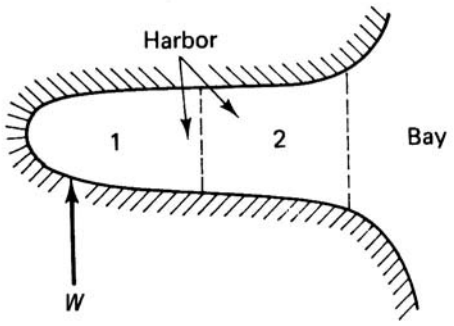
CE 641 FATE AND TRANSPORT MODELING OF ECOSYSTEMS

Tidal Exchange Mass Transport

1. A harbor of a large bay receives a discharge at one end as shown. The harbor is divided into two segments for simplicity.



A conservative substance is released into segment 1 at a rate of 1 kg/day. There is no advective flow through the system. A survey gave the following results:

C_1 = 12 mg/L, C_2 = 5 mg/L, concentration of bay = 1 mg/L

(a) What are the dispersive exchange flows due to mixing of the bay and the harbor, (i.e., between segments 1 and 2 and between segment 2 and the bay, respectively) in m^3/day?
(b) What is the input to the bay from this harbor in kg/day? That is, what is the dispersive flux across the interface between segment 2 and the bay?

2. As a first rough approximation, the lower 50 miles of the Potomac Estuary may be assumed to be composed of two well-mixed segments of water – one above the other – with flow entering the lower layer from the Chesapeake Bay. Mixing between the two layers also occurs. The following conditions are appropriate:

Inflow of fresh water to upper layer = 11,000 cfs
Salinity of inflow = 0
Salinity of upper layer = 10 ppt
Salinity of lower layer = 12 ppt
Salinity of bottom bay water = 14 ppt

Assuming that horizontal dispersion is not significant, but including vertical mixing:
(a) What is the flow entering the lower layer of the estuary from the bay in cfs?
(b) What is the surface outflow from the upper layer to the bay in cfs?
(c) If the surface area is 7.68×10^7 m^2 and each segment depth = 3 m, what is the vertical dispersion coefficient in cm^2/sec?