

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD  
North Coast Region

Interoffice Communication

MEMORANDUM

TO: John Hannum/

DATE: March 19, 1980

FROM: Robert Klamt

SUBJECT: Humboldt Bay Dye Study - February, 1980

The preliminary results of our North Bay Channel dye releases on February 11-13, 1980 are summarized herein. Keep in mind that these data are rough, having received little if any mathematical adjustment, and the conclusions are thus only preliminary and pertinent to the situations under which the study was performed.

With those limitations in mind, the primary objectives of the study were to: 1) provide some coordination with the Winzler and Kelly (W & K) Phase I studies, and 2) provide a prefatory look at the potential of ebb tide effluent discharges to the North Bay Channel of Humboldt Bay.

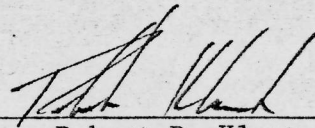
The North Bay Channel is noted for large tidal velocities (2 - 3 kts) near the entrance channel due to its confined channel configuration and the relatively large amount of tidal volume required to pass. The average channel width bounded by 3m depth contours from the mouth of Elk River to the jetties is about 425 meters. Actual shipping channel width is about 140 meters with 10 - 15 meters depth. Cross-sectional configuration of the main channel is largely trapezoidal. Those characteristics provide a potential for short-term periodic ebb tide releases of effluent based on the assumption of passage of some portion of the tidal volume out of the bay.

It was this potential that prompted our efforts to begin to develop a strategy for definition of the period of tidal ebb during which such releases might be made. Our ability to mobilize our dye release - detection equipment and arrange for aerial observation of the releases allowed us to perform this initial study during relatively large tidal fluctuations. At the same time we might provide the Humboldt Bay area entities with some limited information, the W & K group had installed a fixed array of current meters in the North Bay Channel; with the point in mind being mathematical modeling of the tidal velocities in the channel. It was hoped that cooperation by both parties would allow for a more comprehensive definition of the potential for periodic short-term effluent releases during ebb tide periods.

Our chronology of events began with the installation of a tide gauge on the Murray Street pier. A Stevens Model F stage recorder was used with a wooden 12-foot stilling well to provide us with continuous records of tidal heights. As mentioned previously, we were anticipating large tidal fluctuations on the order of 7 feet from higher high water to lower low water. Datum was set by comparison with the NOAA charts, extrapolating from the differences between observed and predicted tidal heights.

John Hannum  
Page 4  
March 19, 1980

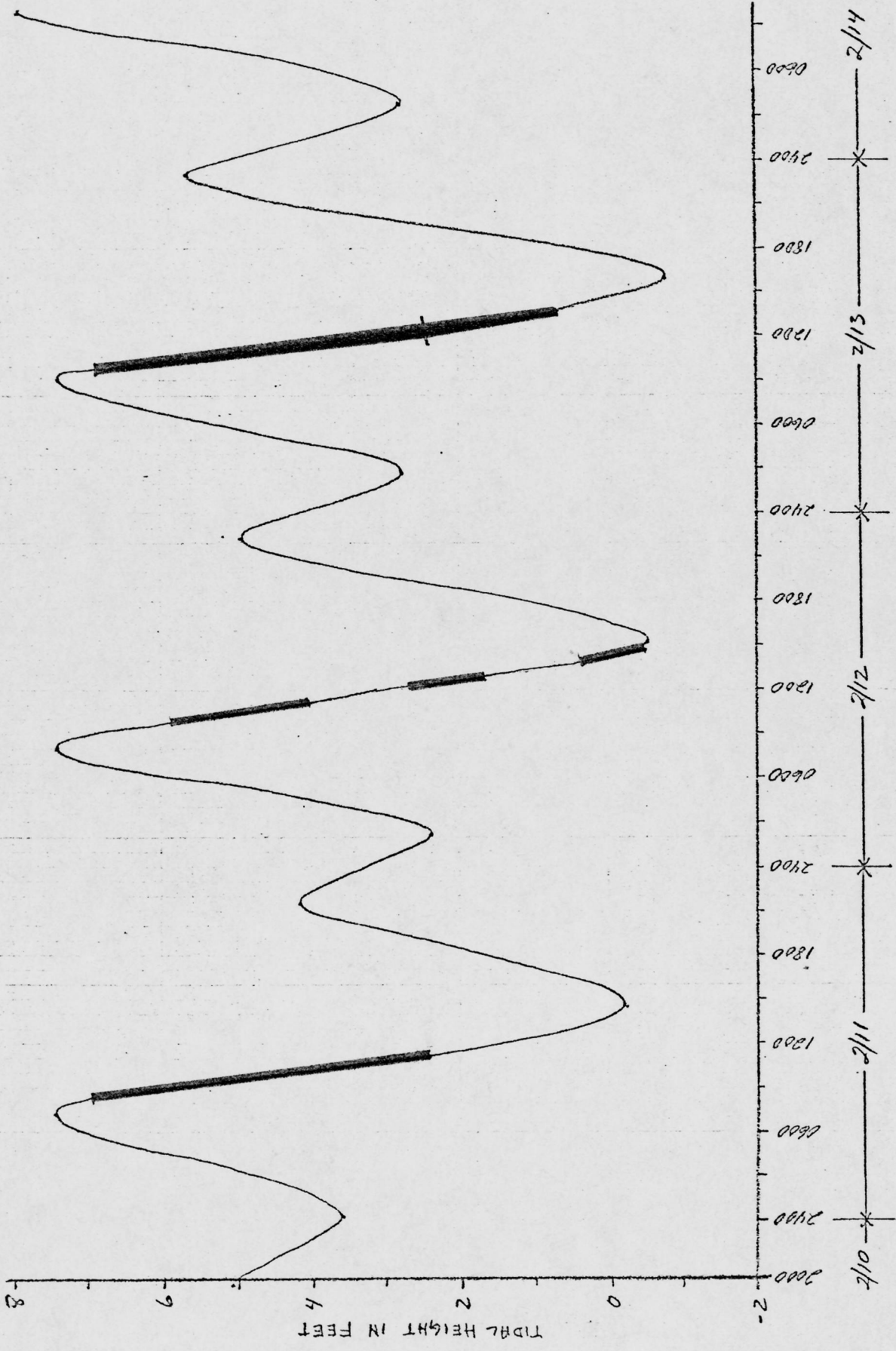
My recommendation is, however, to verify the predictions with another dye study in the near future. Hopefully, W & K can again moor the meters within the channel to aid in the verification. W & K should also receive a copy of this summary to aid in their interpretation of the situation.



---

Robert R. Klamt  
Environmental Specialist

RRK:jmr



FEBRUARY, 1980

Figure 1. Tidal heights at Murray Street pier during February 10-14, 1980. Bold lines indicate those times when dye studies were performed.

Fortunately the weather pattern held during the three days of study. Good visibility with very slight (<5 kt) breezes allowed for excellent aerial observation and coordination. The near absence of wind allowed for undetectable wind shear of the dye releases.

The dye releases consisted of two days of cross-channel lines drawn with a remote slave boat release system. The dye (Rhodamine-WT) was mixed with methanol at a ratio of 60% dye to 40% methanol, giving a specific gravity of about  $1.007 \pm 0.03$ . That mixture was then injected into a mixing vessel at approximately 750 ml/minute, where bay water at 29 gallons/min was also pumped. The water-dye mixture was then released in a line which rapidly spread to about 2m width.

The third day's release was made by tethering the dye release boat to the W & K meter array. A 12 v. DC battery supplied power to both pumps, allowing the work boat freedom to observe and follow the release.

Upon receipt of the aerial photos, the study team plotted the dye line's positions on navigational charts of the bay with the help of cassette-taped narrative from the aerial observers. Water movement behavior and velocities were taken from these charts.

A cross-sectional plot of the channel was also drawn from the navigational chart. The west side of the shipping lane was selected as a baseline, cross-sectional plots were drawn at points of intersection down the baseline at approximately 500 m intervals, the cross-sectional plot will assist with later analysis of the data.

The W & K fixed-meter data was obtained last week in raw form as speeds and directions during time. Some analysis of that data has been undertaken and will be discussed later.

Tide gauge data from a NOAA-Humboldt State University cooperative effort should be forthcoming. That information will permit us to work with a larger data base on tidal activity in the North Bay Channel.

## Results

The observed tidal fluctuations for the period of study are illustrated in Figure 1. The bold areas of the plot are those times during which dye releases were observed.

The dye releases, as mentioned previously, encompassed three tidal ebbs from higher high water to lower low water. Cross-channel releases were used during the first two days; a continuous point release was used on the last day. The results of those releases are summarized below.

February 11, 1980 - Six releases were used on this tidal ebb (Figure 2). The tidal ebb cycle encompassed higher high water of 7.45 ft. at 0712 and lower low water of -0.25 ft. at 1430. The locations of those releases at various times are plotted on Figures 3 - 7. Of the six releases, line "B" was a reinforcement of line "A", which promptly moved out the mouth. The two most useful releases of this day were lines "A" and "E".

John Hannum  
Page 3  
March 19, 1980

Those releases were made from 1.37 to 2.02 hours from higher high water for line "A" and from 2.87 to 3.57 hours from higher high water for line "E". A plot of distance traveled versus time from release illustrates the changes in speed (slope of line) during the tidal ebb as both a function of ebb speed and changes in channel configuration as the dye lines moved down channel (Figure 8). Speed increased throughout the line release "S", however was rather constant during line release "E". Speeds ranged from 32 to 107 meters/minute for line "A", and from 46 to 80 meters/minute for line "E".

February 12, 1980 - Three line releases were used during the tidal ebb of 7.9 ft. (7.4 ft @ 0809, -0.5 ft @ 1511). All releases were made from the red marker "14" on the east side of the channel cross-channel on a compass heading of about 275: the configurations at various times are plotted in Figures 9 - 11. The plots of distance from release (Figure 12) are more complex than for the prior data. Of interest on these plots is the speed change (decrease) as the lines reached that area of the channel which received central bay influence - between PI #2 and PI #3.

The plot of the speed of each line from buoy "12" to buoy "10" against the elapsed time from higher high water began to show the expected rise then fall of ebb speed during the tidal ebb (Figure 13). That information will be used with the W & K fixed meter data to help predict potential times of discharge during ebb tides.

February 13, 1980 - During this day two short-term continuous releases were used. The release point was the W & K fixed meter mooring array. Although not all of the data is complete for this day, some important relationships have become apparent.

The primary result was the determination of the direction of travel from the release point. The importance of this will be discussed in relation to the W & K fixed meter data.

A second result was a plot of dye concentrations at points down the release lines at steady state (Figure 14). These data were obtained with a Turner Designs Model 10 fluorometer with flow-through cuvette and submersible pump sampling system. The effect of rapid dilution is quite apparent, the plot following an apparently-hyperbolic function. One must realize, however, that these data are very limited in scope. The release was a surface release and of much smaller magnitude than any expected effluent discharge. It is paramount that this relatively minuscule dye release not be extrapolated to an effluent discharge situation. Considerably more work will have to be done before one forms any conclusions as to actual dilution rates.

Fixed-meter array - The W & K fixed-meter data is still being analyzed. Preliminary work with the information showed a directional disparity between the upper and lower meters. Also some directional disparity is evident between the meters and the actual dye release. Adjustment of the data to the dye release azimuth is being accomplished with conservation of mass in mind. The particulars are not yet firmed up, however. When that portion of the analysis is complete and combined with the data I am convinced we will have a good method for predicting the potential tidal ebb release window for any particular tide.

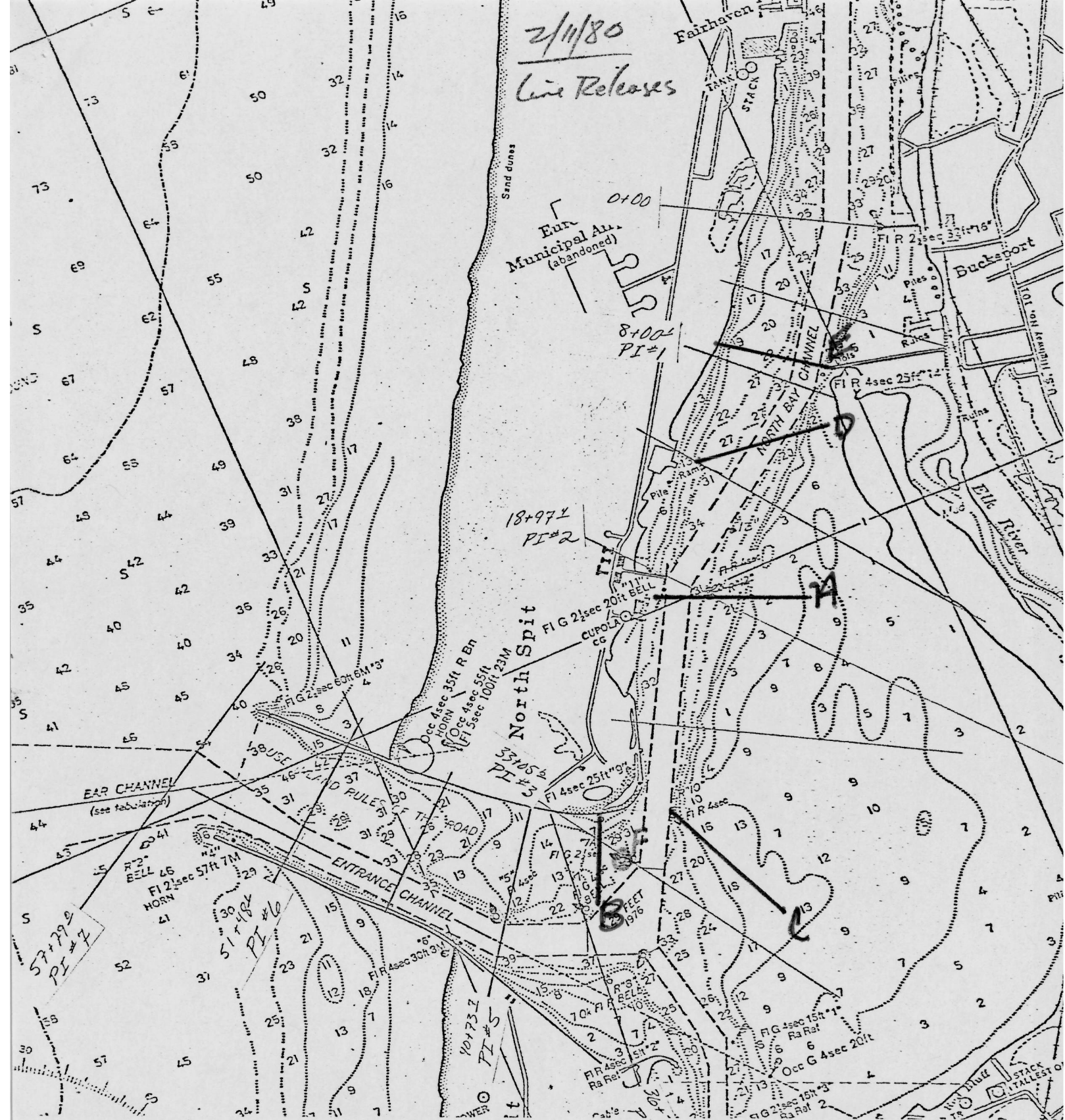


Figure 2. Dye line releases in the North Bay Channel of Humboldt Bay on February 11, 1980.

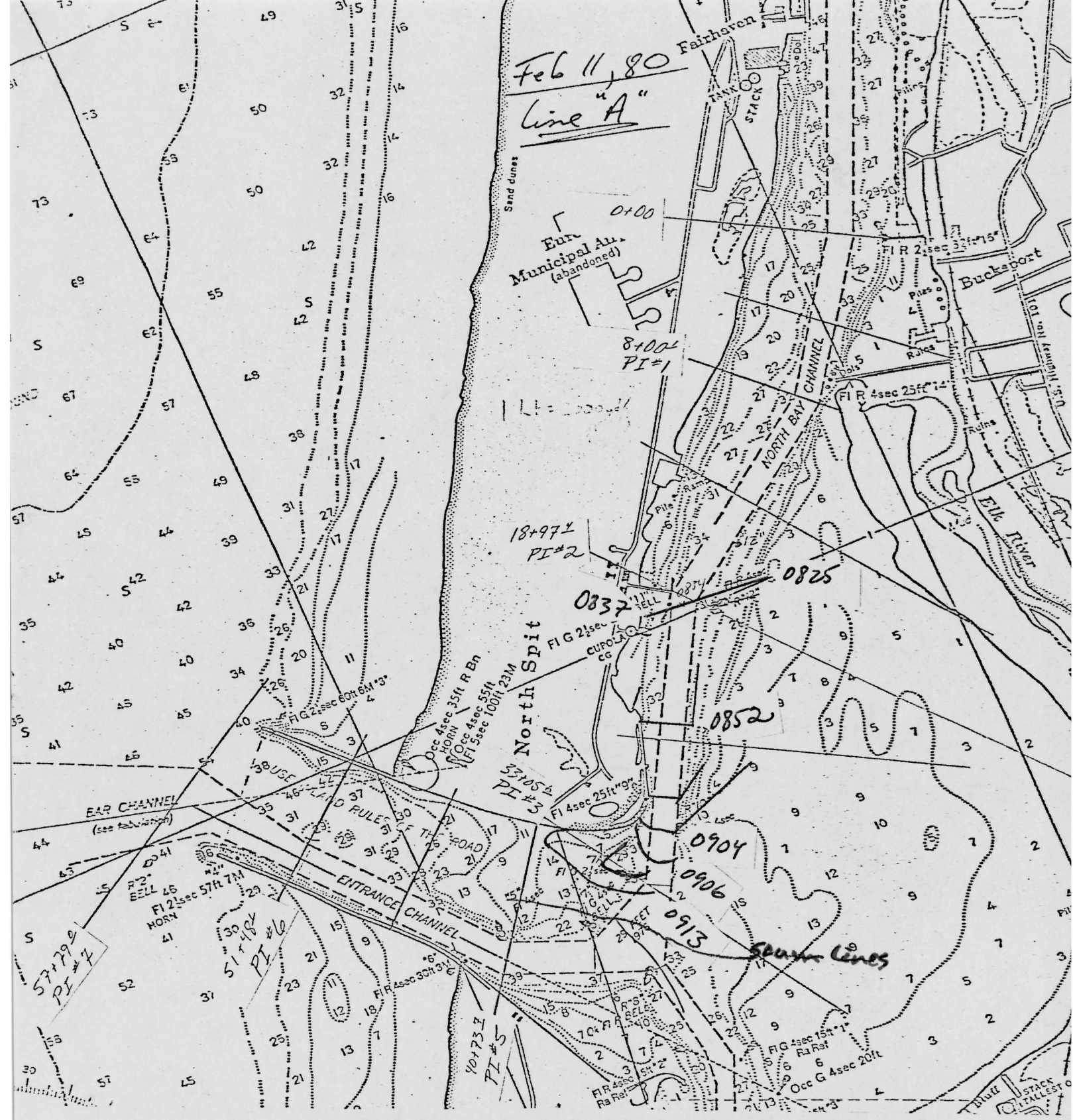


Figure 3. Position of dye line "A" at various times during February 11, 1980.

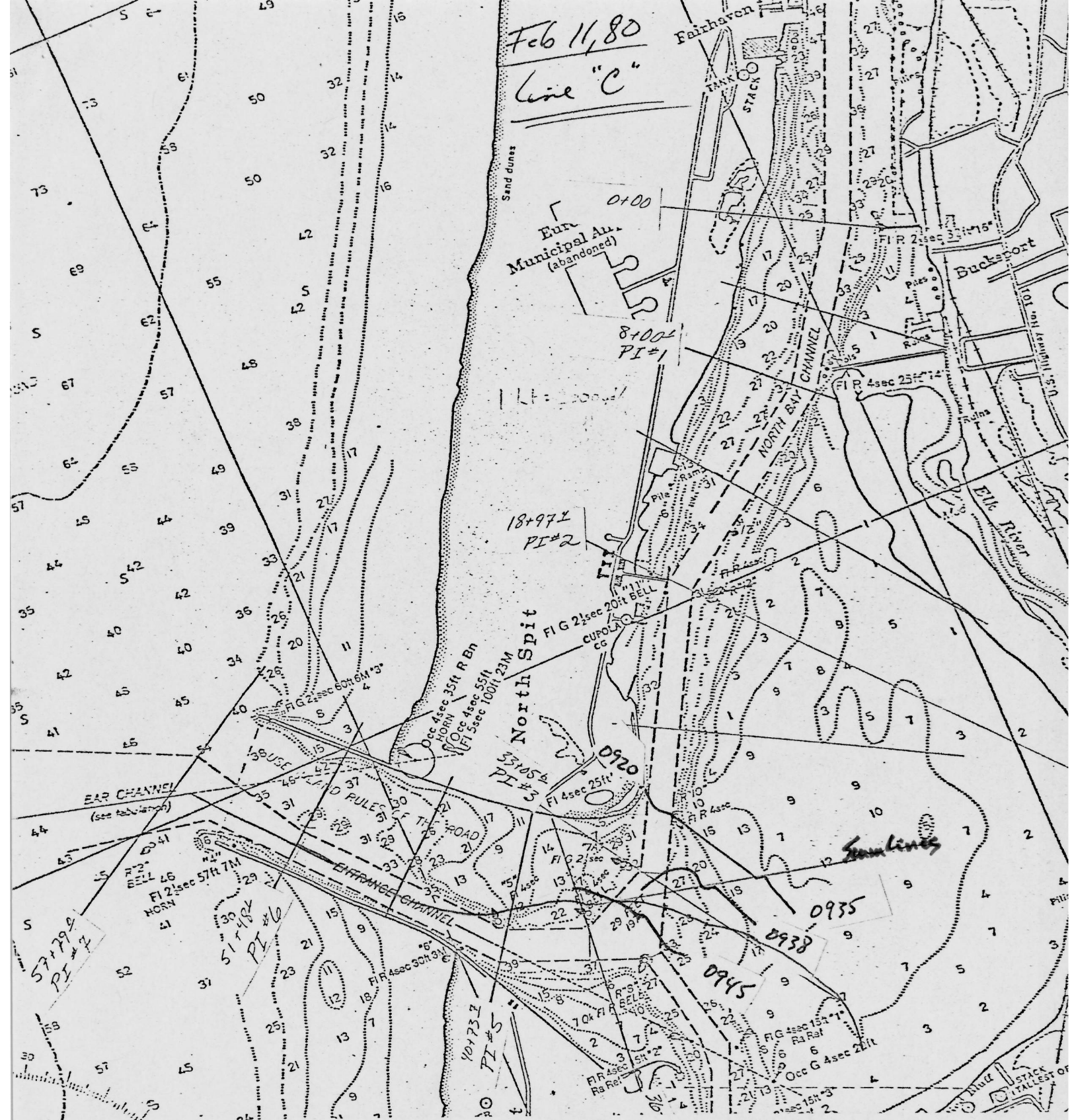


Figure 4. Position of dye line "C" at various times during February 11, 1980.





Figure 5. Position of dye line "D" at various times during February 11, 1980.

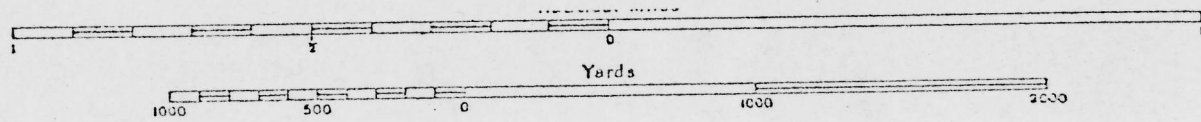
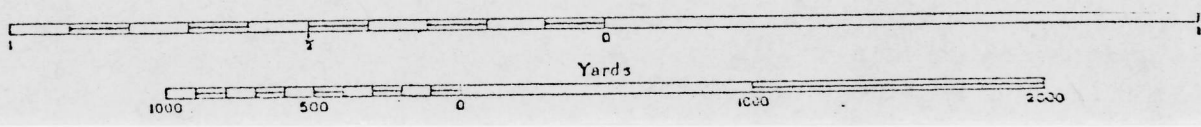




Figure 6. Position of dye line "E" at various times during February 11, 1980.



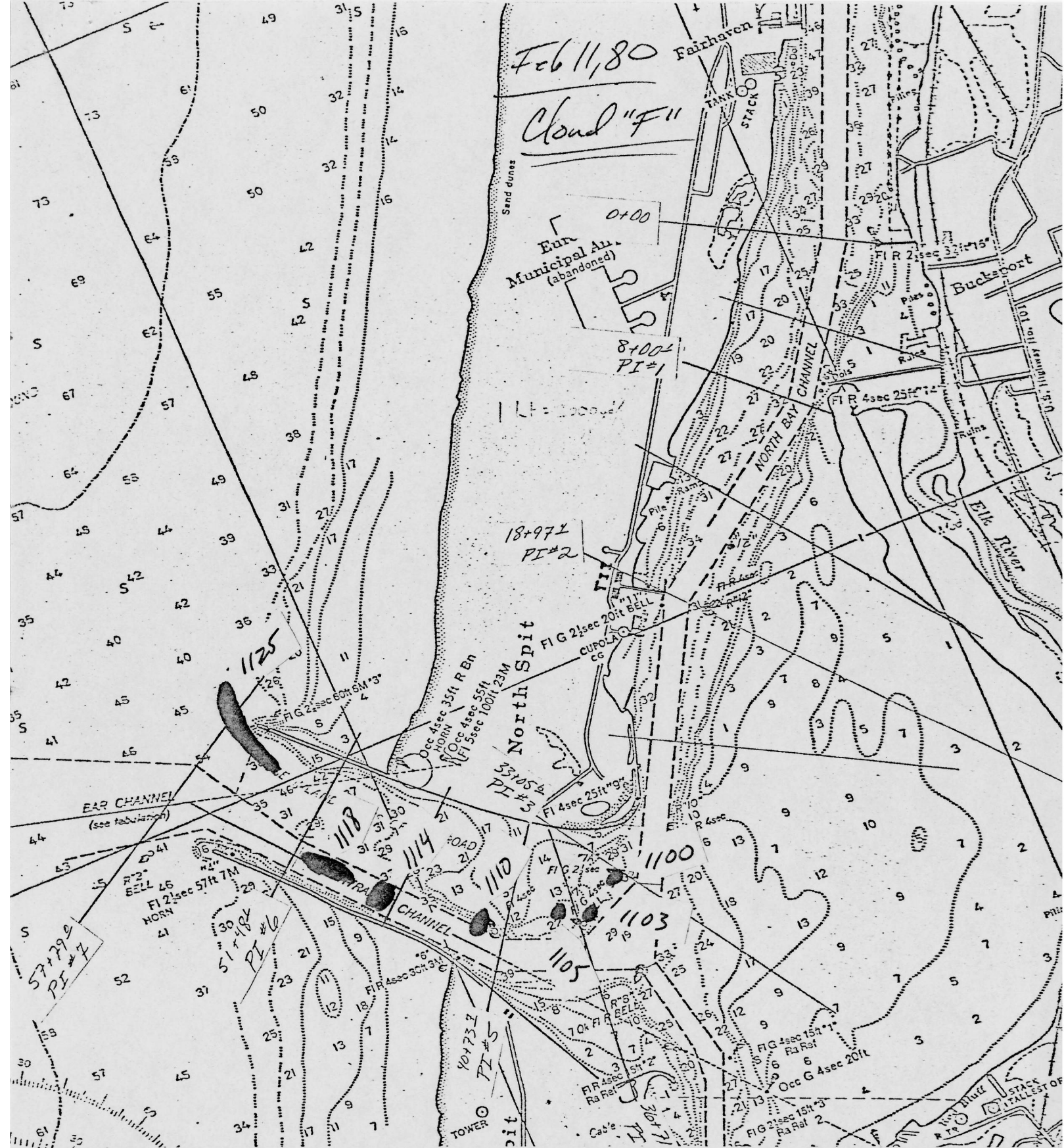
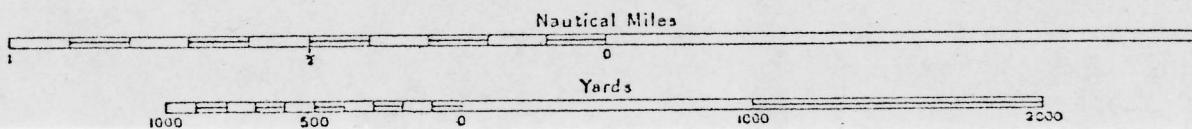


Figure 7. Position of dye cloud "F" at various times during February 11, 1980.



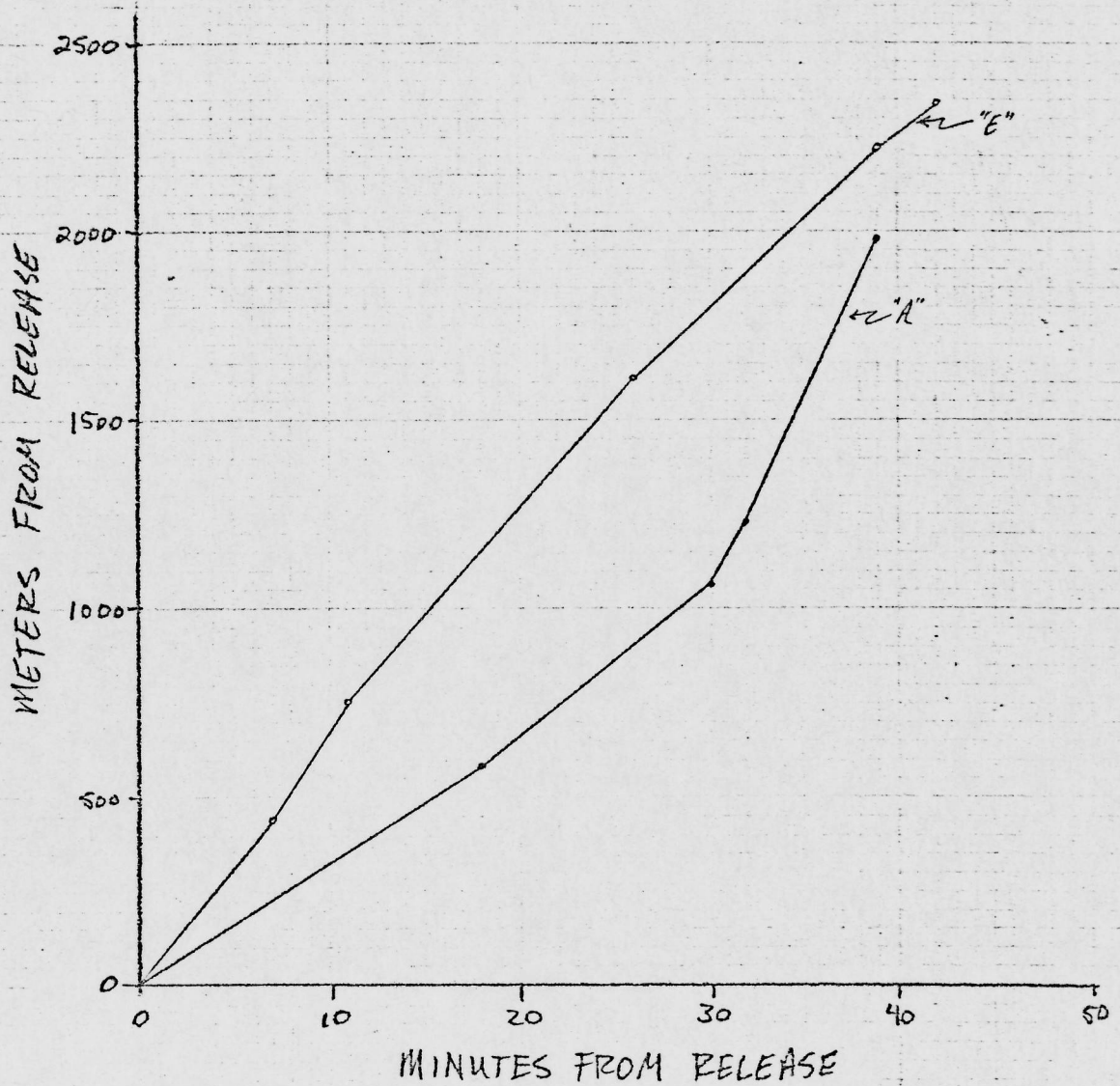


Figure 8. Distance from release point with time from release for dye lines "A" and "E", February 11, 1980. (line "A" = 1.37-2.02 hrs from HHW; line "E" = 2.87-3.57 hrs from HHW)

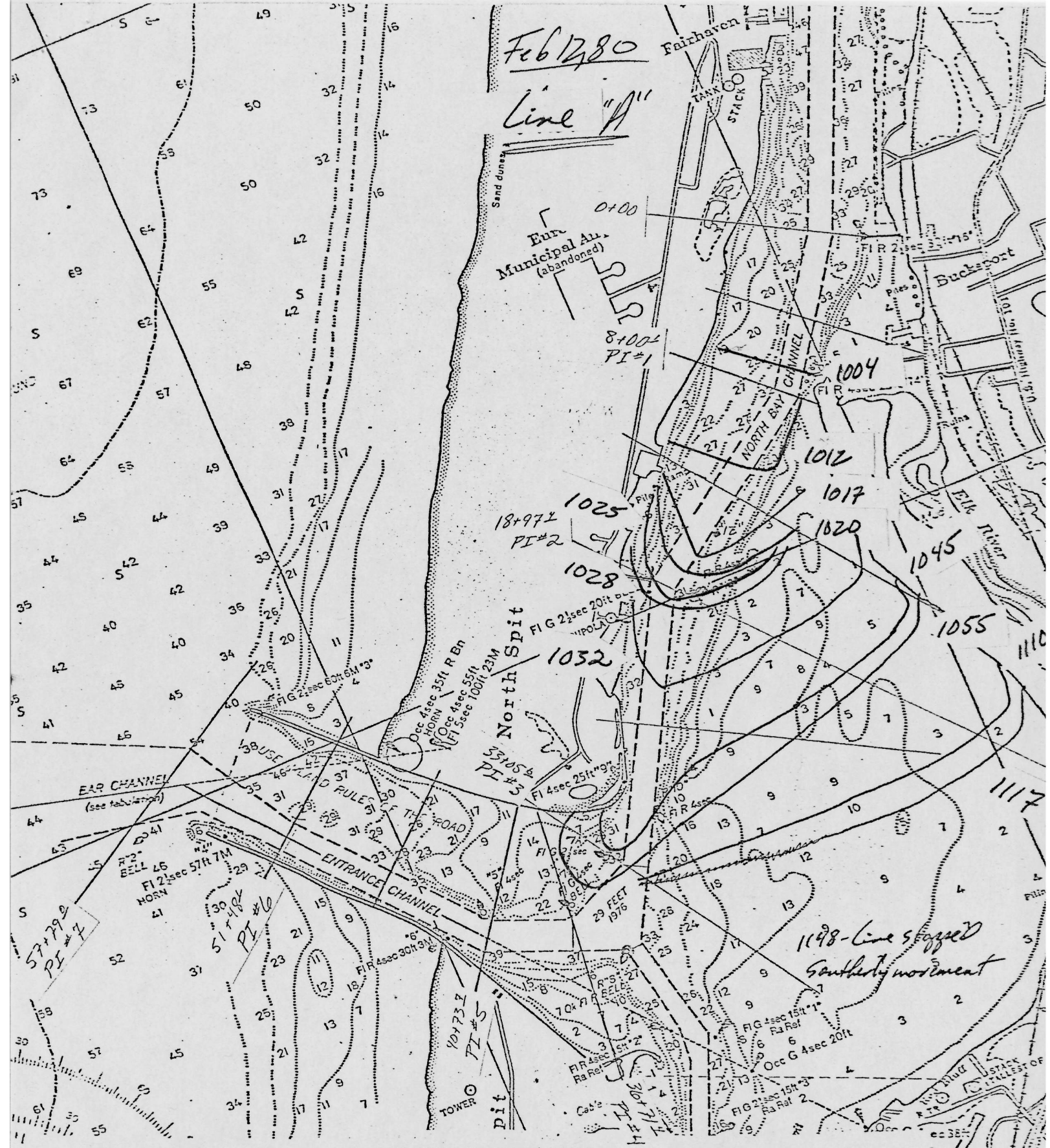
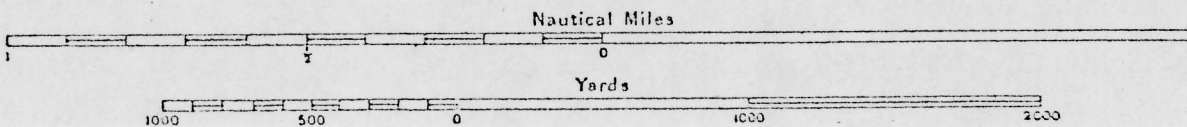


Figure 9. Position of dye line "A" at various times during February 12, 1980.



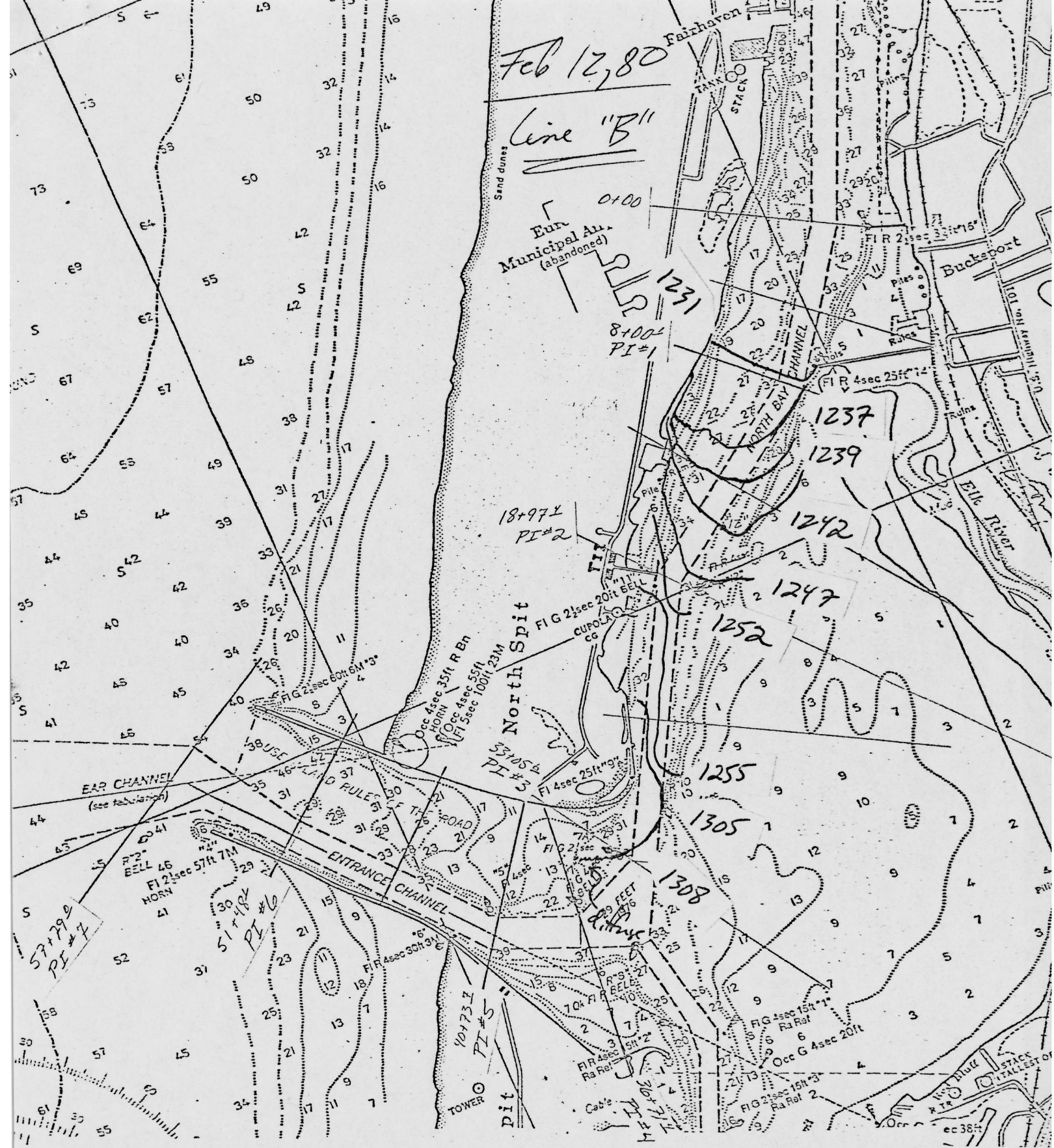


Figure 10. Position of dye line "B" at various times during February 12, 1980.

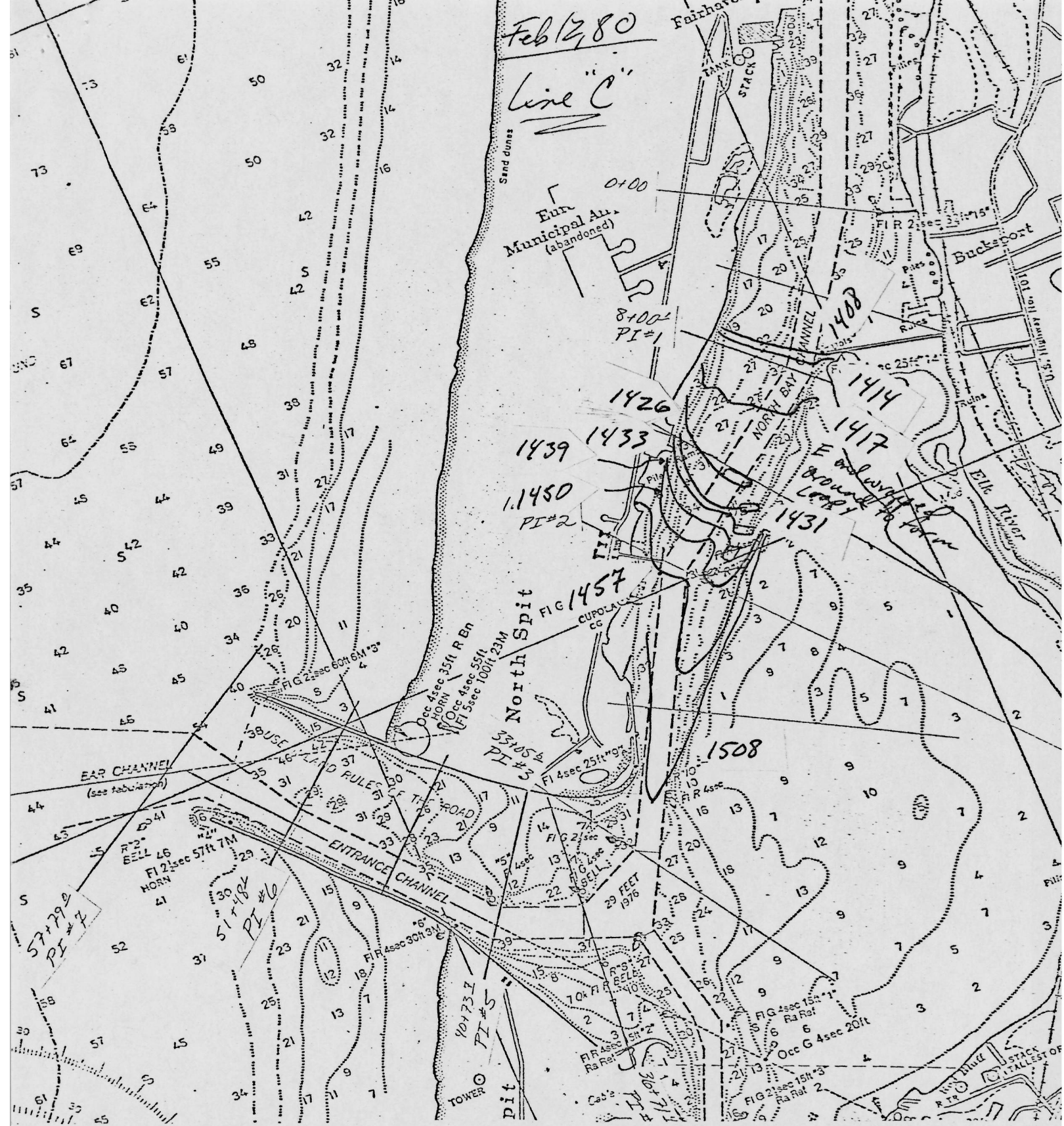


Figure 11. Position of dye line "C" at various times during February 12, 1980.

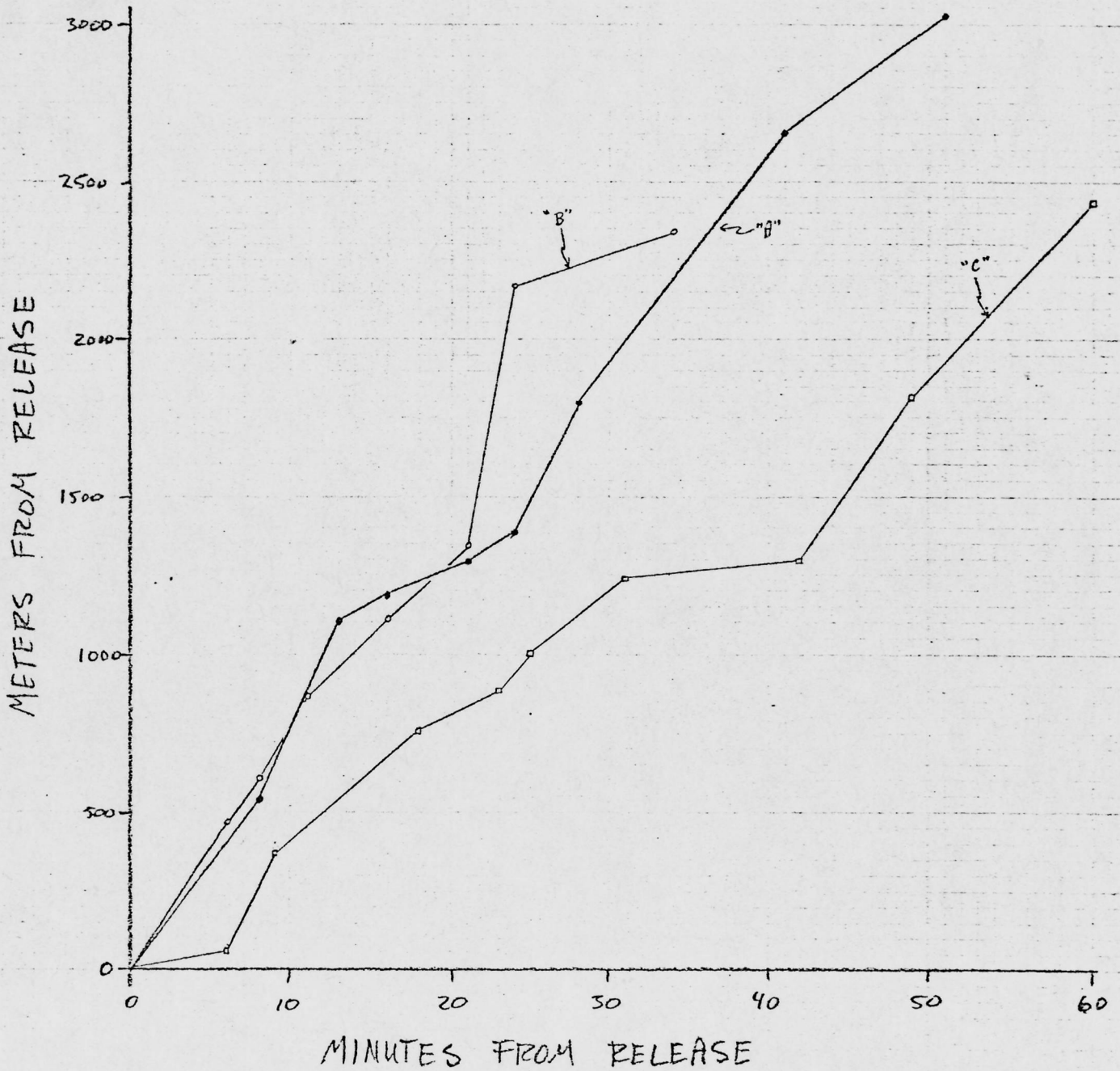


Figure 12. Distance from release point with time from release for dye lines "A", "B", and "C", February 12, 1980. (line "A" = 1.92-2.77 hrs from HHW; line "B" = 4.37-4.93 hrs from HHW; line "C" = 5.98-6.98 hrs from HHW)



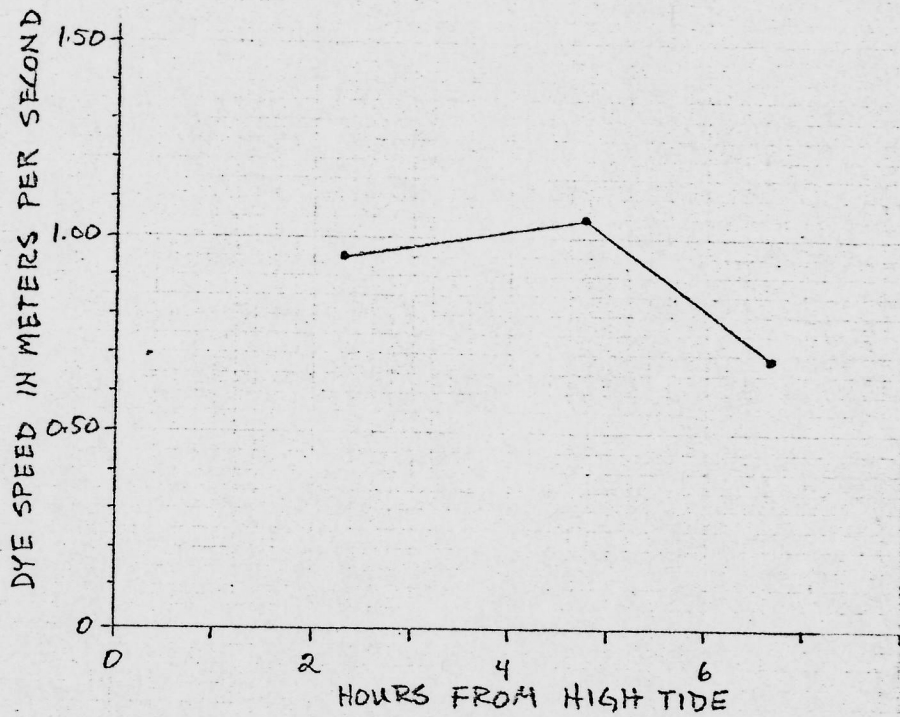


Figure 13. Speeds of dye lines from buoy "12" to buoy "10" with time from high tide during February 12, 1980. (tidal ebb period = 7 hours)

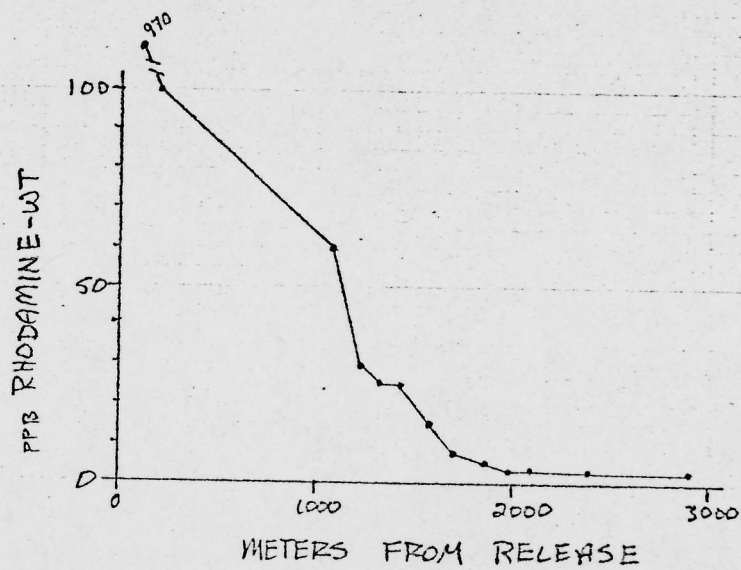


Figure 14. Dye concentrations with distance from the release point for continuous release # 2, February 13, 1980.