AN EXAMINATION OF THE STABILITY OF THE PORT OF LONDON AUTHORITY ESTUARY DECCA HI-FIX CHAIN

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The Port of London Authority Estuary Decca Hi-Fix Chain was set up in 1965 as an aid to hydrographic surveying and dredging operations. The hyperbolic chain layout was designed to provide the best general cover to that part of the estuary significant to navigation (figure 1). In 1967 the chain configuration was altered by moving the Slave II station from Clacton to Orfordness. The main parameters of the present (1974) chain layout are given in table 1. The chain alteration was made in order to improve the Hi-Fix cover of the northern part of the estuary in association with the decision to route large tankers into the Thames via Long Sand Head and Black Deep Channel, instead of through the more restricted Edinburgh

TABLE I

The Port of London Authority Estuary Hi-Fix Chain

			Coordinates in metres in National Grid of Great Britain	
Frequency 1899.5 kHz				
Master Transmitter position (North Foreland)			638346.99 E	171612.98 N
Slave I Transmitter (Allhallows)			583772.97 E	178436.27 N
Slave II Transmitter (Orfordness)			644922.20 E	248823.60 N
Base line lengths :	Pattern I	54990.59 metres		
	Pattern II	77465.42 metres		
Base line lane widths :	78.876020 metres (assuming a speed of propagation of 299650 km/sec).			
Number of lanes :	Pattern I	697.178		
	Pattern II	982.116		

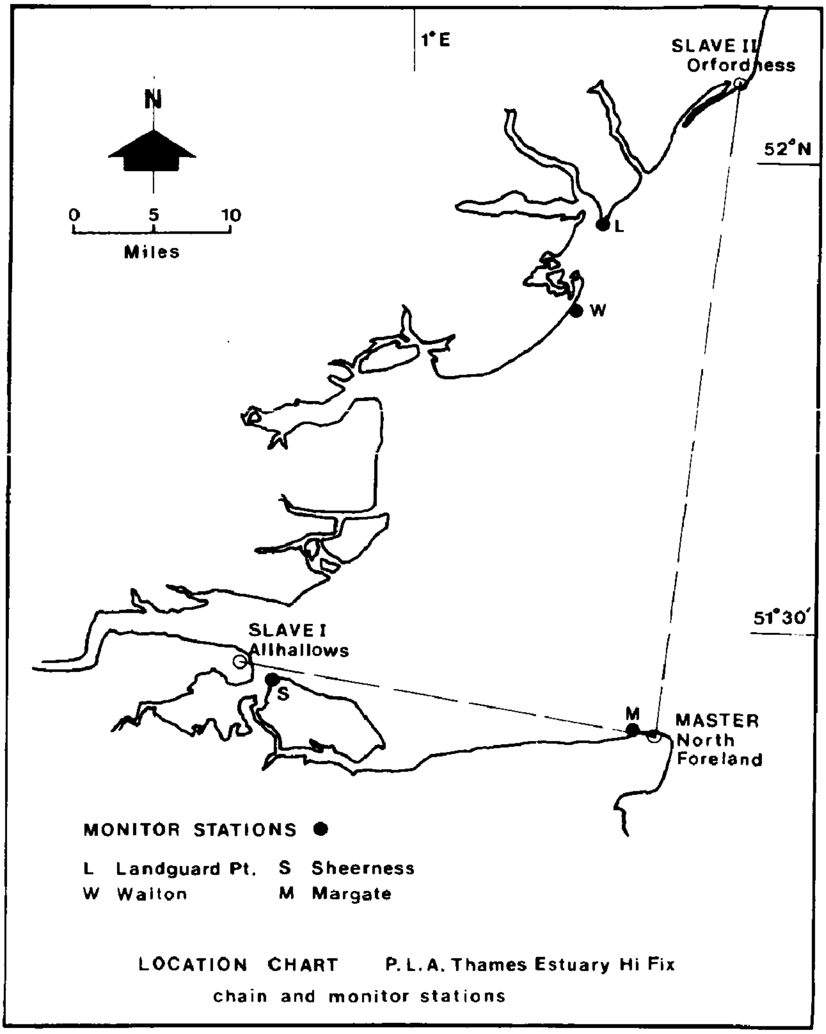

FIG. 1.

Channels. The complex navigational problems of the Thames Estuary are discussed by WHITE (1972).

In order to ascertain the operational accuracy of the Hi-Fix chain a series of monitoring studies have been carried out in conjunction with the Port of London Authority (table 2). For these studies Hi-Fix receivers were set up at various fixed sites on shore around the estuary. Owing to the lack of suitable structures with the necessary power supplies and access, it was not possible to monitor the Hi-Fix pattern away from the shore. For most of the studies Hi-Fix receivers were interfaced with twin track analog recorders. These proved to be only partially suitable in that they required frequent attention and the amplitude of shift that could be recorded was restricted to a maximum of ± 15/100ths of a lane. In later studies on two occasions a Decca data logger was used; this recorded Hi-Fix pattern data at ten second intervals, regardless of the amplitude of shift. A preliminary report by HOOPER (1971) gave details of the analysis of the earlier recorded data.

TABLE II

Data used for Hi-Fix Monitor Studies

	1970	1971	1972	1973
January			S(2)	O4, S3
February				O4, S3
March		S(2), W(2)		
April		NF(2)		
May				
June				
July	A1, O(1), S(1)			O4, S2
August	A(1), O(1), S2, W1			O4, S2 + 3, L2
September	S(2), M(2)		S(2), M(2)	O4, S2, L2
October		O4, S2, W2	O4, S(2), M(2), W(2)	
November		O4, S2, W2	O4, S2, M2	
December		S2, W(2)	O4, S2, M(2), W(2)	

Location

A = Allhallows
O = Orfordness
S = Sheerness
M = Margate
W = Walton
L = Landguard Pt
NF = North Foreland

Type of data

1 = Single track analogue recorder
2 = Twin " " "
3 = Decca data logger
4 = Rain gauge
( ) Poor data, or of limited period

Analysis of the recorded data shows that short and long period deviations of the Hi-Fix patterns occur. The former are defined as having a period of less than ten minutes, whilst the latter may continue for several hours.

SHORT PERIOD DEVIATIONS

The following three types of short period disturbance causing pattern deviations can be readily identified from the recorded data :

(a) A continous small amplitude "noise" type fluctuation occurs. This is related to propagation conditions and the general state of the component electronics (Figures 2 and 3).

(b) Re-radiation produced by a large vessel passing close to the monitor site can cause localised pattern disturbance. Figure 2 shows the pattern fluctuation resulting from two tugs and a large dredger passing within half a mile of the monitor station. No relatable fluctuation was recorded at the monitor station at Walton.

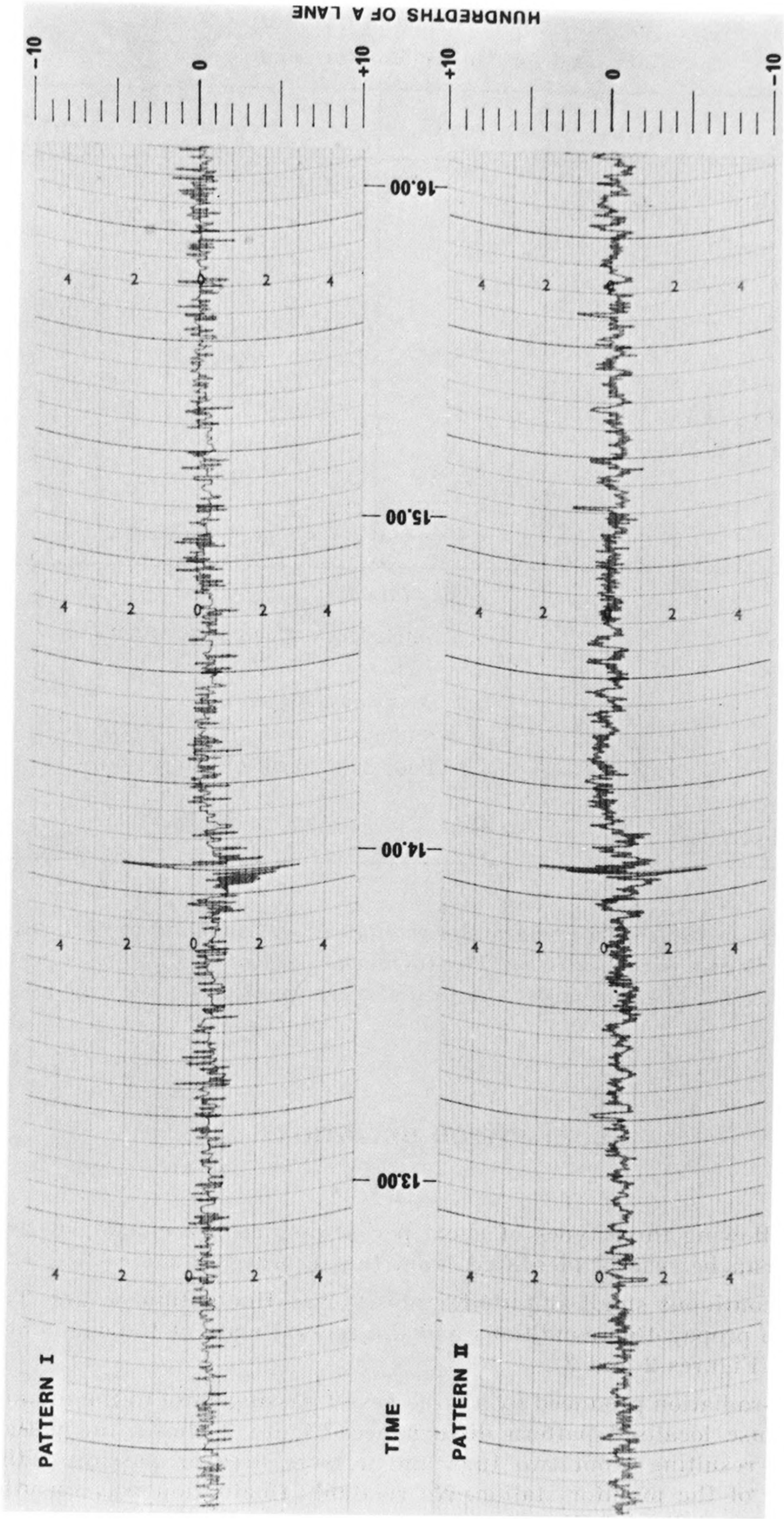

FIG. 2. — Pattern fluctuations caused by a large vessel passing close to the Sheerness monitor station at 14.00 on 21 March 1971.

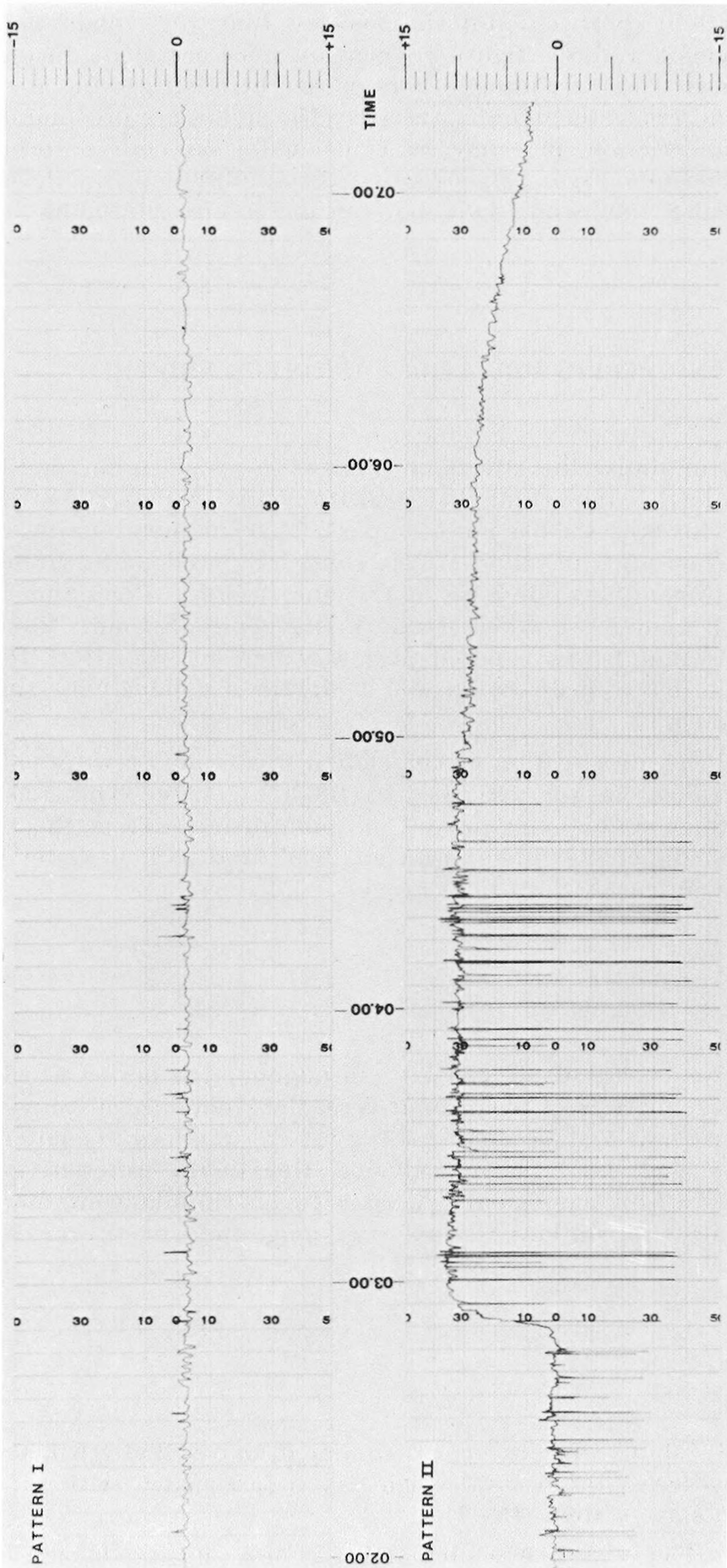

FIG. 3. — Hi-Fix monitor records Sheerness : 21 August 1970. Onset of rainfall at Orfordness 02.50.

(c) Intermittent short period deviations (less than 10 seconds) causing "spikes" on analogue records (figure 3) occur on some occasions during the period of darkness. These are thought to be caused by mistriggering at either the slave transmitters or the monitor receiver. The spikes are predominantly in the negative direction and may be coincidental on both patterns or restricted to either one. Figure 3 shows that the amplitude of the deviation is normally about 8/100ths of a lane, but can increase to 20/100ths during rainfall.

LONG PERIOD DEVIATIONS (PATTERN SHIFT)

In order to minimise the effects of changes in propagation conditions for a Hi-Fix chain it is important that land transmission patterns are kept to a minimum. This however has not been possible at the monitor sites used, as in all cases they are subject to effects caused by land paths from one or more chain transmitters. Because of this the recorded fluctuations are probably greater than those which occur in the Outer Estuary. BRADLEY (1970) concludes that banks exposed at low water do not affect Hi-Fix accuracy in that they remain damp and maintain a conductivity similar to that of seawater.

Throughout the investigation no correlation was found between pattern shift and tidal range, as was described by BRADLEY (1970). This was not unexpected as the monitor sites are all at some distance from the chain transmitters, and the change in ratio of length of land path to water path does not alter significantly with tidal range.

a) Pattern I

Pattern I remains relatively constant throughout the period of observations. Typically, analysis of mean hourly readings obtained at Sheerness between the 3rd and 31st August 1973 gives a standard deviation of 1.23/100ths of a lane about the mean value. Due to the different transmission paths only poor agreement existed between simultaneous monitor recordings at different stations, though the magnitude of the deviation remained similar.

b) Pattern II

The general stability of Pattern II is similar to that of Pattern I, except when positive pattern shift occurs which can be associated with rainfall at the Pattern II slave station (fig. 4).

The Pattern II slave station is sited at Orfordness and stands on a large expanse of shingle of some 15 m thickness (CARR, 1967). The earth mat for

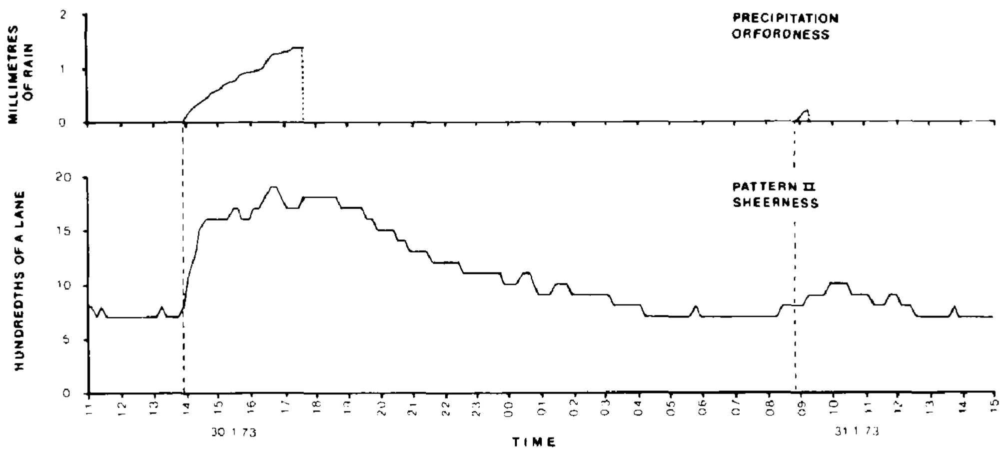

FIG. 4. — The coincidence of pattern shift with rainfall.

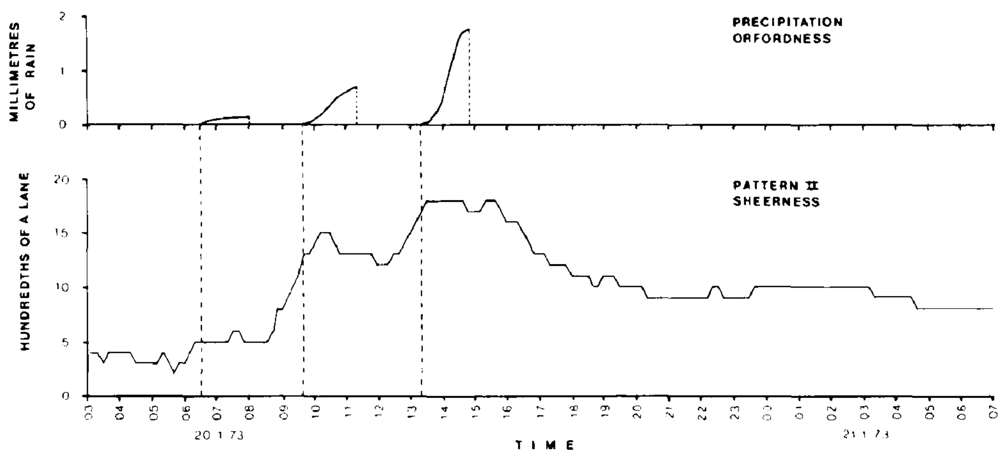

FIG. 5. — Three phases of pattern shift associated with rainfall.

the transmitter aerial is buried and anchored in the surface shingle. Both the water table and the water content within the shingle bank fluctuate with precipitation and tidal height, thus altering the effective earthing conditions at different levels.

It is considered that most instances of long period pattern shift in the positive direction are related to earthing conditions at the slave II transmitter, which in turn are related to rainfall at the slave station. No correlation can be detected between pattern shift and tidal height, whilst no data is available on the changes in water content in the bank during the periods of monitoring. No equivalent shift occurs on Pattern I which suggests that the pattern disturbance is related to the conditions at the Pattern II slave transmitter and not to the propagation conditions in the Estuary.

With the onset of rainfall at Orfordness positive pattern shift occurs on Pattern II. Within between fifteen minutes to three hours, depending upon the intensity of rainfall, a maximum shift is attained. This does not increase with continuing rainfall, suggesting that a limiting condition is reached. Records from the Decca data logger which was used in January and February 1973 show that the full extent of the pattern shift reached between 12 and 15/100ths of a lane at Sheerness. After rainfall ceases the pattern shift reverts to normal over a period of up to twenty hours. The recovery period probably depends upon the drying conditions, and subsequent rainfall during this period again offsets the pattern (fig. 5). The initiation of pattern shift does not always coincide with the onset of rainfall. This may be partially explained by the distance of 3 km between the slave station and the site of the rain gauge, in that the onset of rain is not necessarily at the same time at the two locations. In the case of the data presented in figure 5, the occurrence of snow may have delayed the response of the rain gauge.

The comparison of monitor records obtained at Sheerness with those obtained at Landguard Point shows that although time coincident, the amplitude of pattern shift associated with rainfall is greater at Landguard Point. This indicates that the entire shift is not produced only by the local effect at the slave II transmitter. In addition secondary factors, such as different propagation velocities over different transmission paths, probably occur.

As a result of information gained in the monitor observations carried out in January and February 1973 an attempt was made to improve the earth mat at the Orfordness slave station. Metal rods were driven 7m into the shingle and connected to the outer ends of the wires forming the earth mat. These modifications have resulted in some improvement in that the monitor records obtained during July and September 1973 at Sheerness show that pattern shifts associated with rainfall are reduced to 10 to 12/100ths of a lane.

CONCLUSIONS

Unless the long period fluctuations can be eradicated, it seems necessary that at least one permanent recording monitor station should be maintained and the relevance of its data established throughout the Estuary. This objective will be maintained in future studies in which it is also hoped to obtain and incorporate monitored data from offshore sites.

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CARIBBEAN SURVEY

A lover of the sea, President Franklin D. ROOSEVELT often recuperated from his strenuous duties by taking fishing trips. Summoning an aide, he would say " Call the Hydrographic Office and find out where the fishing is good ". During the 1930s, funds for hydrographic survey work were scarcer than usual and Hydro was especially anxious to survey areas rarely entered by merchant or Navy ships, but considered strategically important. For several years, therefore, an inspired gentleman at Hydro would reply that the fishing was particularly good in the Caribbean.

While the President happily fished from the deck of a cruiser in areas remote from shipping traffic, fathometers obtained the soundings Hydro needed to complete its bottom contour charts of the Caribbean.