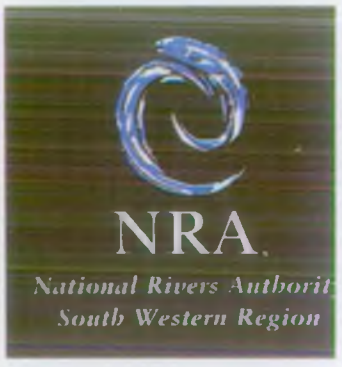
Investigations Into the Extent of Saline Water Ingress Into the River Parrett and the River Tone

February, March 1994

North Wessex Investigations Team

NWI/94/1



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Summary

This report presents the findings of a further study into the extent of saline intrusion into the River Parrett and River Tone. This was undertaken by measuring the conductivity of the river water at intervals along their tidal stretches throughout the cycles of two tides during flood and normal flow conditions.

During flood conditions, the limit of saline water intrusion was found to be on the River Parrett between Town Bridge and Somerset Bridge. In normal flow conditions, the limit was found to be slightly further upstream, between Somerset Bridge and Moorland. The water was also found to have a significantly higher conductivity in the saline section of the river under these conditions.

CONTENTS

1.0 INTRODUCTION

1.1 Background and Preliminary Investigation

Saline water enters the River Parrett from the Severn Estuary on the incoming tide. The salinity is diluted by freshwater from the upper sections of the Parrett and its tributaries in Somerset and Dorset.

Following allegations from farmers that saline floodwater was damaging grass on Curry Moor, an earlier investigation was undertaken to determine the salinity of the floodwater entering the moor from the River Tone, a tributary of the River Parrett during a high tide period. Samples were taken of the Rivers Parrett and Tone in order to try and estimate how far saline water from the Severn Estuary intrudes into the system on an incoming tide.

The preliminary investigation concluded that only freshwater had spilt onto Curry Moor from the Tone and it was estimated that salt water may not have intruded much further up the Parrett than Bridgwater.

1.2 Aims of the Further Investigation

A further investigation was undertaken to examine the limit of saline water intrusion into the tidal sections of the rivers Parrett and Tone during spring tide conditions. This was undertaken by measurement of conductivity of the water in the rivers along their tidal sections through the cycle of two tides. Two surveys were carried out; one each during flood and normal flow conditions.

Conductivity is a good indicator of salinity and can be easily and accurately measured on site. The more saline the water, the higher the ion concentration and hence the conductivity.

1.3 Survey Conditions

1.3.1 28th February 1994

For the first survey, there were predicted high tides at Bridgwater of 7.1 metres at 08:13 hours (GMT) and 7.0 metres at 20:37 hours (GMT). The actual peak tidal heights recorded were 7.64m and 7.14m at 08:38 and 21:00 respectively. Low tide was recorded at 14:30 hours.

There had been snow and heavy rain the previous week and although the floodwaters were subsiding, freshwater flows in the rivers were higher than normal. This caused the tides to be later and higher than predicted.

1.3.2 29th March 1994

On this occasion, high tides at Bridgwater were predicted as 7.2m at 08:52 hours (BST) and 7.0m 21:15 hours (BST). The actual peaks were recorded as 7.38m at 09:29 and 7.16m at 21:53.

The previous week had been mostly dry and consequently freshwater flows were as expected for the time of year, and lower than they had been in February.

2.0 INVESTIGATION

2.1 Sampling Sites and Methods

The sites identified for investigation were:

Site 1 - River Parrett at Black Bridge NGR ST 300 374

Site 2 - River Parrett at Town Bridge NGR ST 301 371

Site 3 - River Parrett at Blake Bridge NGR ST 302 368

Samples were taken at the above sites from both the river bed and near to the surface by hand using a Casella depth sampling device. Samples were taken every half hour for the period 2 hours before and 2 hours after each high tide and every hour in the intervening period. The conductivity of the samples was determined in situ using a Grant/YSI 3800 water quality logger.

Site 4 - River Parrett downstream of Somerset Bridge
NGR 306 357

Site 5 - River Parrett at Somerset Bridge NGR ST 311 356

Site 6 - River Parrett at Moorland NGR ST 343 324

Site 7 - River Parrett at Burrow Bridge NGR ST 357 404

Site 8 - River Tone at Cut Row Bridge NGR ST 347 291

Site 9 - River Tone at Hook Bridge NGR ST 336 278

The locations of these sites are shown in Figure 1.

Automatic monitors were left at sites 4 - 9 to log measurements of conductivity from the river bed at 10 minute intervals. At sites 5,6,8 and 9 Grant/YSI loggers were used and at site 7, Burrow Bridge, conductivity was measured automatically using a Hydrolab Datasonde 3 logger on 28th February and a Grant/YSI logger on 29th March. The Datasonde was used downstream of Somerset Bridge (site 4) on 29th March. In addition, measurements were obtained from close to the water surface using a Grant/YSI logger at site 9, Hook Bridge.

3.0 RESULTS AND DISCUSSION

The results are shown in Figures 2 to 5.

3.1 February 28th 1994

3.1.1 River Parrett Sites

Figure 2 shows the change in conductivity of the River Parrett at sites 1,2,5,6 and 7 during the two tidal cycles on 28th February.

At Black Bridge and Town Bridge there was a marked increase in conductivity during the flood tide, peaking at 0.64mS/cm (Black Bridge) and 0.63mS/cm (Town Bridge) during the high tide and decreasing to a level between 0.53mS/cm and 0.55mS/cm on the ebb tide. This can be attributed to the ingress of saline water with the flood tide.

At the Somerset Bridge and Moorland sites the conductivity stayed more constant and at lower levels than at Black and Town Bridges. There were some small fluctuations in conductivity around the high tide times though these were less pronounced at Moorland. In general, The conductivity was lower at Moorland than at Somerset Bridge.

At Burrow Bridge the conductivity measurements were typically 0.03mS/cm higher than at the more downstream sites. These elevated results could be explained by the use of the different type of apparatus at this site. A sharp fall in conductivity was observed 80 minutes after the first high tide followed by a high sharp peak of 0.65mS/cm at 130 minutes after high tide. This pattern was repeated at Somerset Bridge 20 minutes later but at a much lower level, and it was not seen at Moorland.

The origin of this pattern is difficult to ascertain. It is unlikely to be due to saline intrusion as it happened long after the high tide. It may be due to a slug of water from further up the Parrett which was highly conducting for reasons other than salinity, for example the presence of sewage effluent. This seems unlikely however as no similar pattern was observed in the Tone despite the presence upstream of a large sewage treatment works at Ham, which serves Taunton and many outlying villages. Several days had also passed since the roads were last salted so saline road drainage is unlikely to have entered the river and affected conductivity measurements.

3.1.2 River Tone Sites

Figure 3 shows the change in conductivity of the River Tone at sites 8 and 9 over the same tidal cycles.

Conductivity measurements at the sites on the River Tone were significantly lower than in the Parrett. There were no peaks at high tide and this indicates that there is no saline intrusion into the Tone at high tide.

3.1.3 Variation Between Bed and Surface Water

The variation in conductivity of the river water at the surface and bed was assessed during this survey. The results are shown in Appendix 1. No significant difference between the surface and bed measurements were detected.

3.2 March 29th 1994

3.2.1 River Parrett Sites

Figure 4 shows the change in conductivity of the River Parrett at sites 2 to 7 during the two tidal cycles on 29th March.

Smooth peaks were observed in the conductivity of the Parrett at sites 2 to 5 (Town Bridge to Somerset Bridge) which coincided with each high tide. No increases in conductivity were detected at sites 6 or 7 (Moorland and Burrow Bridge).

The conductivity measurements were significantly higher at all sites in the saline section of the river than during the previous survey. For example the morning peak at Town Bridge was 11.33mS/cm compared with 0.63mS/cm on 28th February. This is almost certainly due to the lower freshwater flows.

The high tide peaks at Town Bridge and Blake Bridge were very pronounced, rising to 11.33mS/cm and 9.86mS/cm respectively at 0930 hours. At Somerset Bridge and the site downstream of Somerset Bridge, lower peaks were recorded, 3.85mS/cm and 3.55mS/cm respectively. The graphs for Moorland and all sites further upstream showed no peaks at all, the conductivity being similar to those recorded during the previous survey, typically around 0.5mS/cm.

It can be concluded from the data obtained in the second survey that during normal flow conditions, salt water can intrude into the River Parrett as far as Somerset Bridge but not as far as Moorland.

3.2.2 River Tone Sites

Figure 5 shows that there was no increase in the conductivity of the Tone at site 8, Cut Row Bridge, during this survey.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 On 28th February 1994, during flood conditions at spring high tide, the saline limit of the Tidal River Parrett was found to be somewhere between Town Bridge and Somerset Bridge.

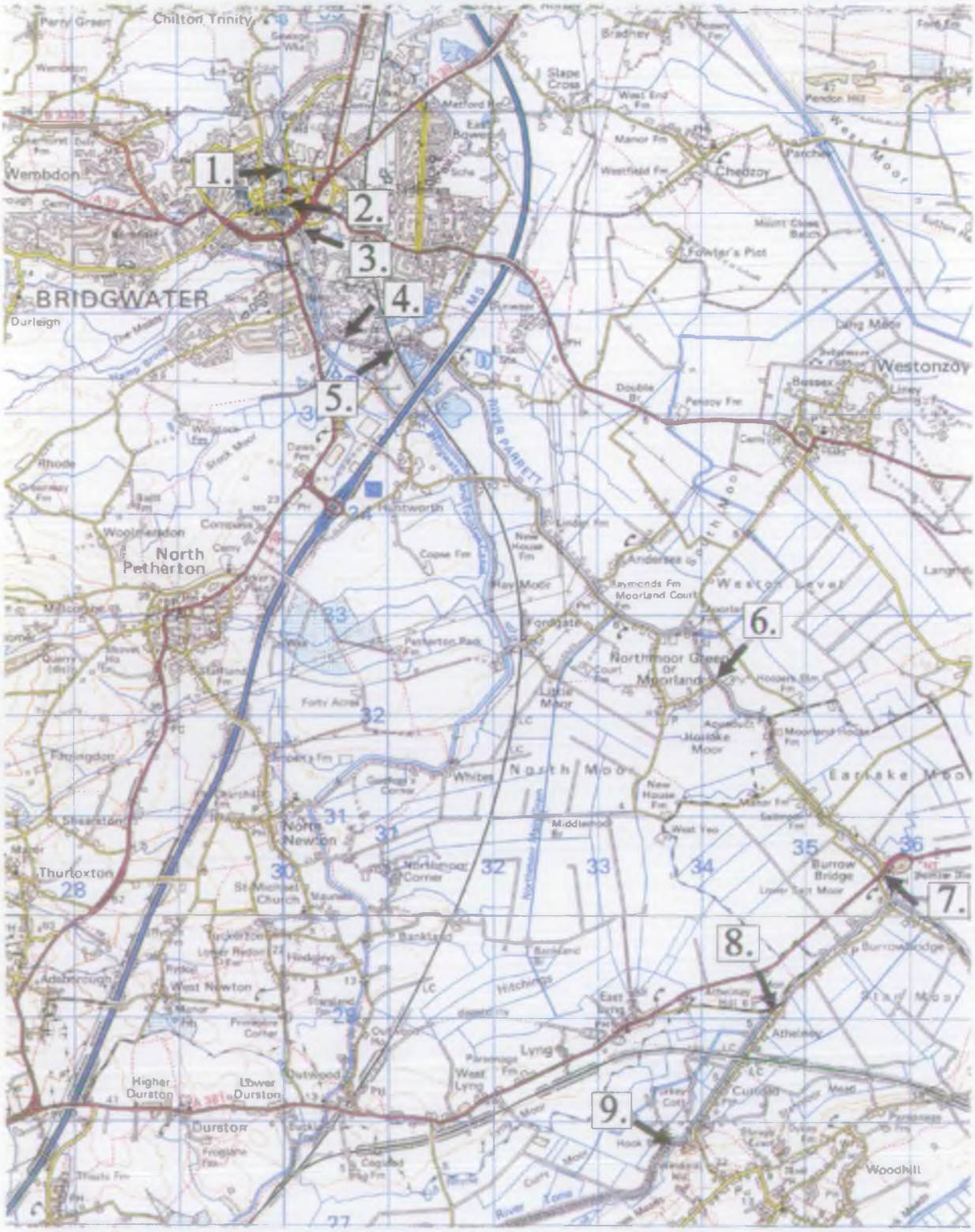
4.2 On 29th March 1994, during normal flow conditions at spring high tide, the saline limit of the Parrett was further upstream, between Somerset Bridge and Moorland.

4.3 The amount of freshwater flowing down the river system significantly affects both the limit of saline intrusion and the levels of salinity attained. During periods of low freshwater flows, saline water intrudes further upstream and higher conductivity levels are experienced in the river.

4.4 No saline intrusion was observed in the tidal section of the River Tone under either set of conditions.

4.5 It seems probable that the greatest extent of saline intrusion will occur on spring high tides during drought conditions, and if the maximum limit of saline intrusion is to be discovered, this work should be repeated under these conditions.

FIGURE 1 MAP OF SAMPLING SITES



KEY

1. River Parrett at Black Bridge
2. River Parrett at Town Bridge
3. River Parrett at Blake Bridge
4. River Parrett D/S Somerset Bridge
5. River Parrett at Somerset Bridge
6. River Parrett at Moorland
7. River Parrett at Burrow Bridge
8. River Tone at Cut Row Bridge
9. River Tone at Hook Bridge

Results

CONDUCTIVITY OF RIVER PARRETT AND RIVER TONE

Figure 2

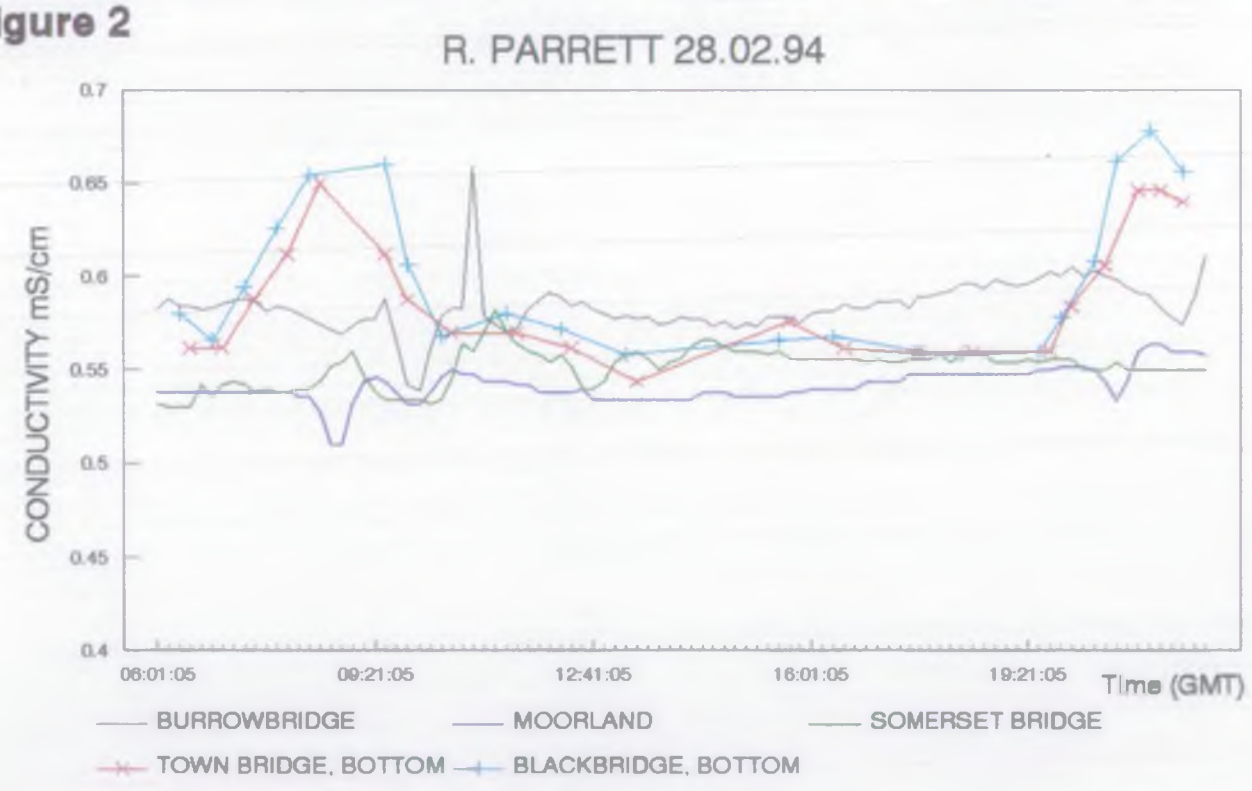


Figure 3

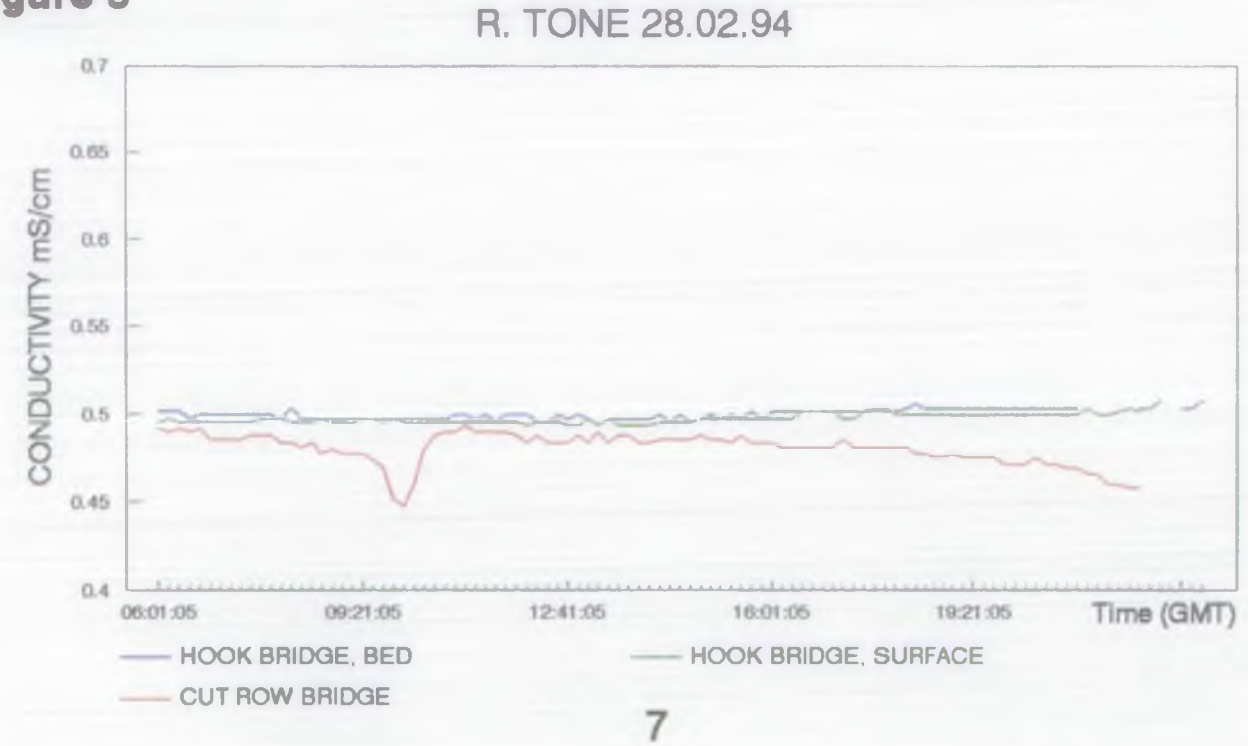


Figure 4

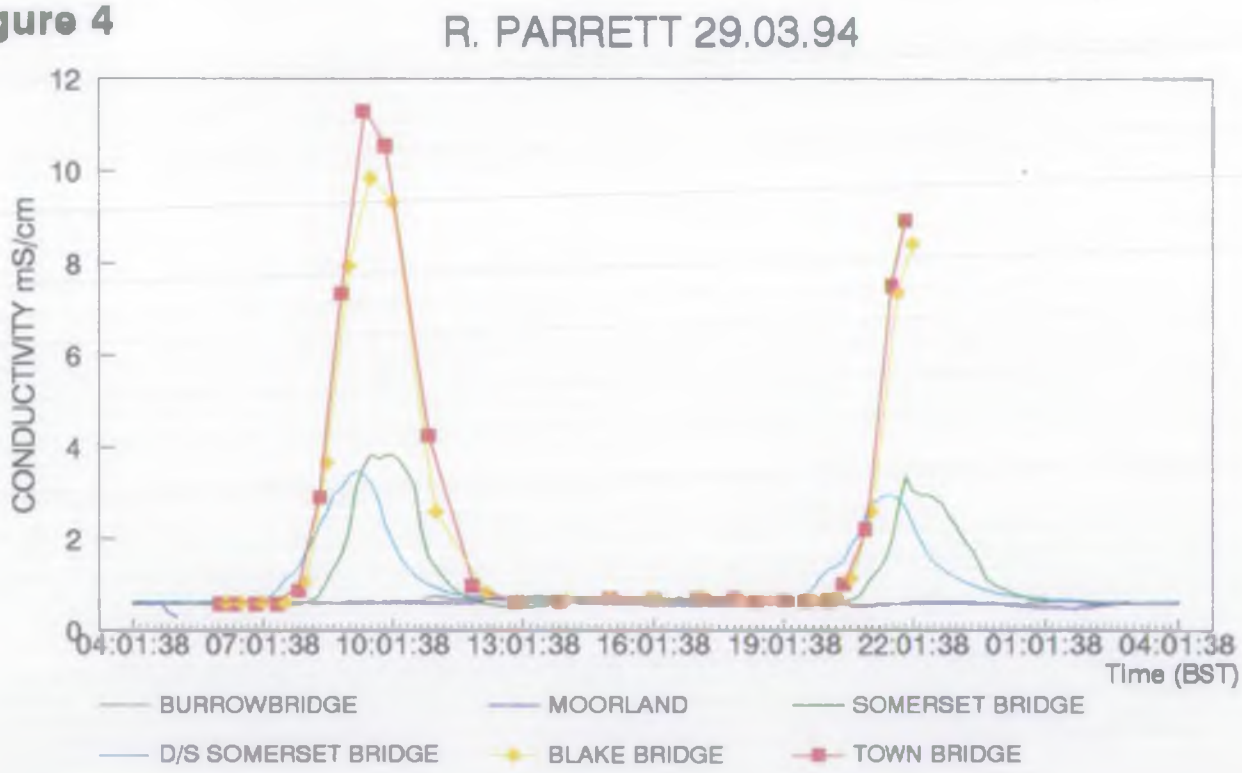
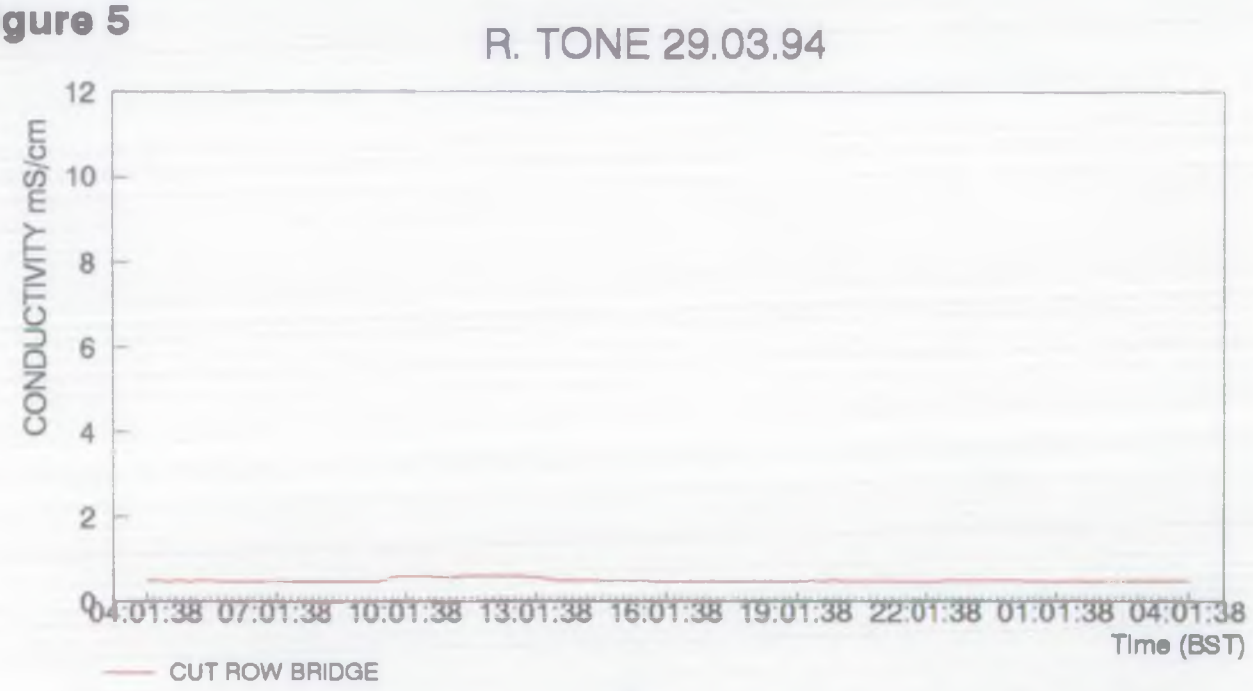


Figure 5



Appendix 1

COMPARISON OF BED AND SURFACE SALINITY

Figure 6

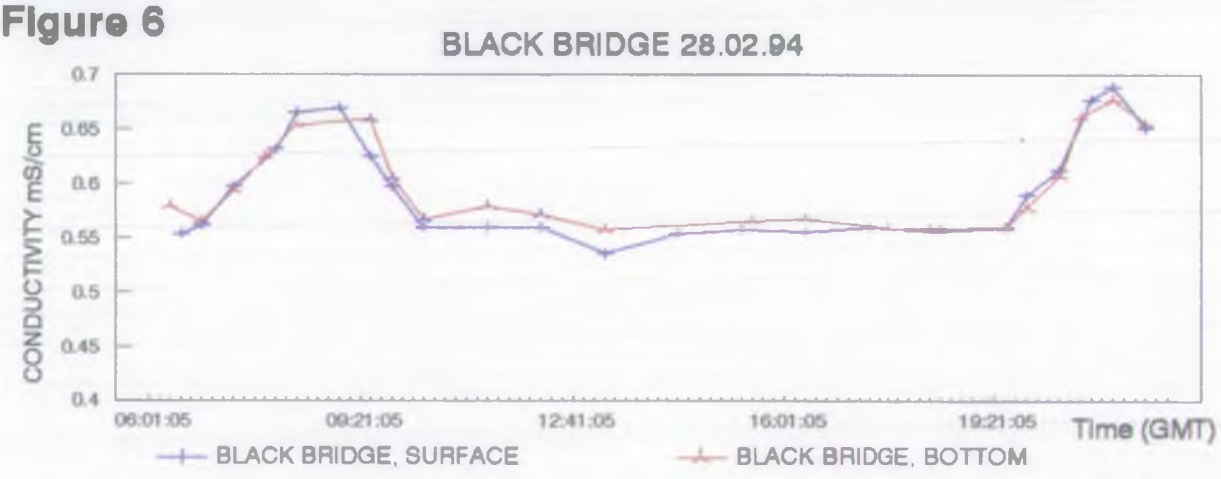


Figure 7

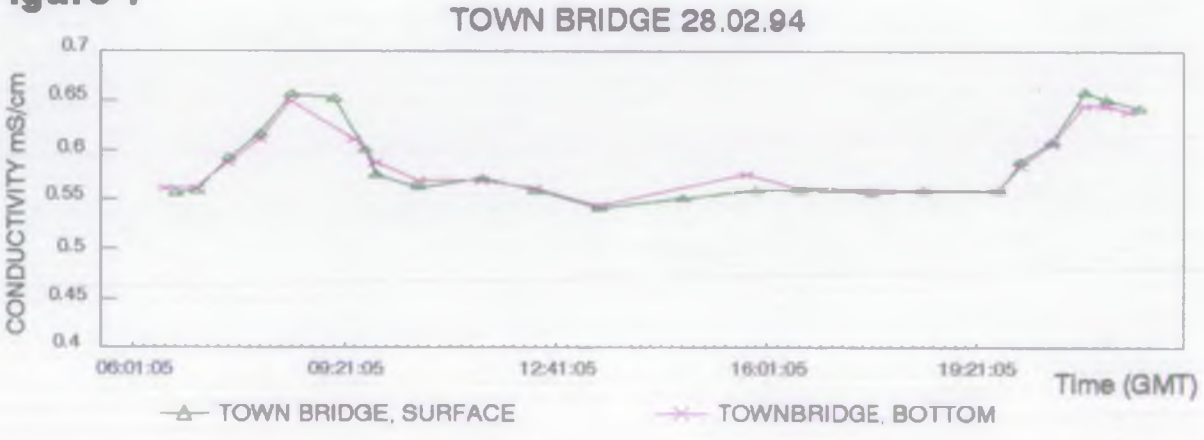


Figure 8