ENGLISH NATURE

Northey Island managed retreat

Report 6: Results to February 1996

No. 185 - English Nature Research Reports

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Northey Island Managed Retreat
Report 6
Results to February 1996

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February 1996

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Report No. Z062-96-F

Report to English Nature
(Contract No. UF04/04

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1. INTRODUCTION

Monitoring of geomorphological development of the managed retreat scheme on Northey Island has been continuing on a twice yearly basis since the scheme was implemented 4.5 years ago. In the latest monitoring campaign the work was carried out in September 1995 and February 1996. The methodology adopted at the commencement of the project has been continued in order to provide a time series of data and enable all the results to be assessed on the same basis.

The data being collected therefore includes:

- topographic survey of the site;
- accretion measurements along a transect extending from the back of the site through the spillway and across the mudflat to low water;
- accretion measurements distributed spatially across the site;
- analysis of sediment grain size characteristics across the site;
- general photographic record of site development, including vegetation colonisation, creek development and condition of the new walls.

This report represents the last in the present twice-yearly monitoring series, which will subsequently be replaced by bi-annual monitoring. Details of the rationale behind the scheme, and the monitoring methodology, are presented in previous reports and are not repeated here.

2. RESULTS OF MONITORING

The approach taken in the past two reports is to draw together the survey results in order to analyse long term trends. This approach is therefore continued in this final report for this monitoring phase, with all results presented together and discussion of the latest findings.

2.1. Topography

Contour maps of the site from both the September 1995 survey and that of February 1996 are included in Appendix 1. In report 5 it was suggested that the contours, particularly those at the lower end of the site, were moving progressively further inland, while those along the upper parts of the site had remained stable. This trend continued between February 1995 and September 1995, but comparison of the two latest maps shows very little change between the two latest surveys, even when one map is overlain directly on the other. As in previous years minor changes may be seen in the detailed configuration of the contours which may be attributed to differences in the actual placement of the random survey points. The overall pattern of the contours, however, is much more similar than observed in previous years. This suggests that some degree of stability in the topography may have been achieved by this stage, i.e. 4.5 years after the breach.

The results of incorporating the two most recent surveys into the statistical analysis are given in table 1 below. Full details of the rationale and methodology used for the statistical analysis are presented in report 5.

Table 1. Mean elevations of marsh surface (excluding creeks) for each survey date

Survey date	Actual mean elevation	Standard deviation	Variance	Count
August 1991	2.927	.105	.011	46
January 1992	2.892	.128	.017	67
August 1992	2.913	.149	.022	181
February 1993	2.888	.135	.018	127
July 1993	2.903	.118	.014	144
February 1994	2.952	.104	.011	214
September 1994	2.967	.145	.021	122
February 1995	2.988	.159	.025	221
September 1995	2.968	.134	.018	266
February 1996	2.976	.138	.019	292

The results of the t-test analysis used to determine statistical differences between the datasets are presented in table 2, with those values which are greater than 2.326 and therefore significant at or above the 0.01 level (i.e. more than 99% significant) shaded.

Table 2. T-values for differences between datasets.

	Jan-92	Aug-92	Feb-93	Jul-93	Feb-94	Sep-94	Feb-95	Sep-95	Feb-96
Aug-91	1.502	0.600	1.774	1.223	-1.461	-1.701	-2.495	-1.965	-2.301
Jan-92		-1.018	0.198	-0.605	-3.830	-3.506	-4.510	-4.155	-4.531
Aug-92			1.509	0.657	-3.042	-3.127	-4.853	-4.066	-4.682
Feb-93				-0.974	-4.884	-4.448	-5.977	-5.514	-6.040
Jul-93					-4.103	-3.950	-5.507	-4.865	-5.430
Feb-94						-1.090	-2.783	-1.425	-2.130
Sep-94							-1.209	-0.066	-0.595
Feb-95								1.507	0.914
Sep-95									-0.692

Figure 1 shows the overall change in mean surface elevation from commencement of the scheme to the present day. The initial loss of the surface peat layer is shown as a lowering of the surface, followed by a period of variability as the surface elevation fluctuated with no overall net change. From July 1993, however, there was a period of net accretion, reaching a peak elevation of 2.988 mOD in February 1995, 3.5 years after the breach. From this point there now appears to be a further period of variability, again with very little net change, although the surface is now lower than the peak level. This confirms the findings of the contour analysis which also suggest that the topography has reached overall stability for the

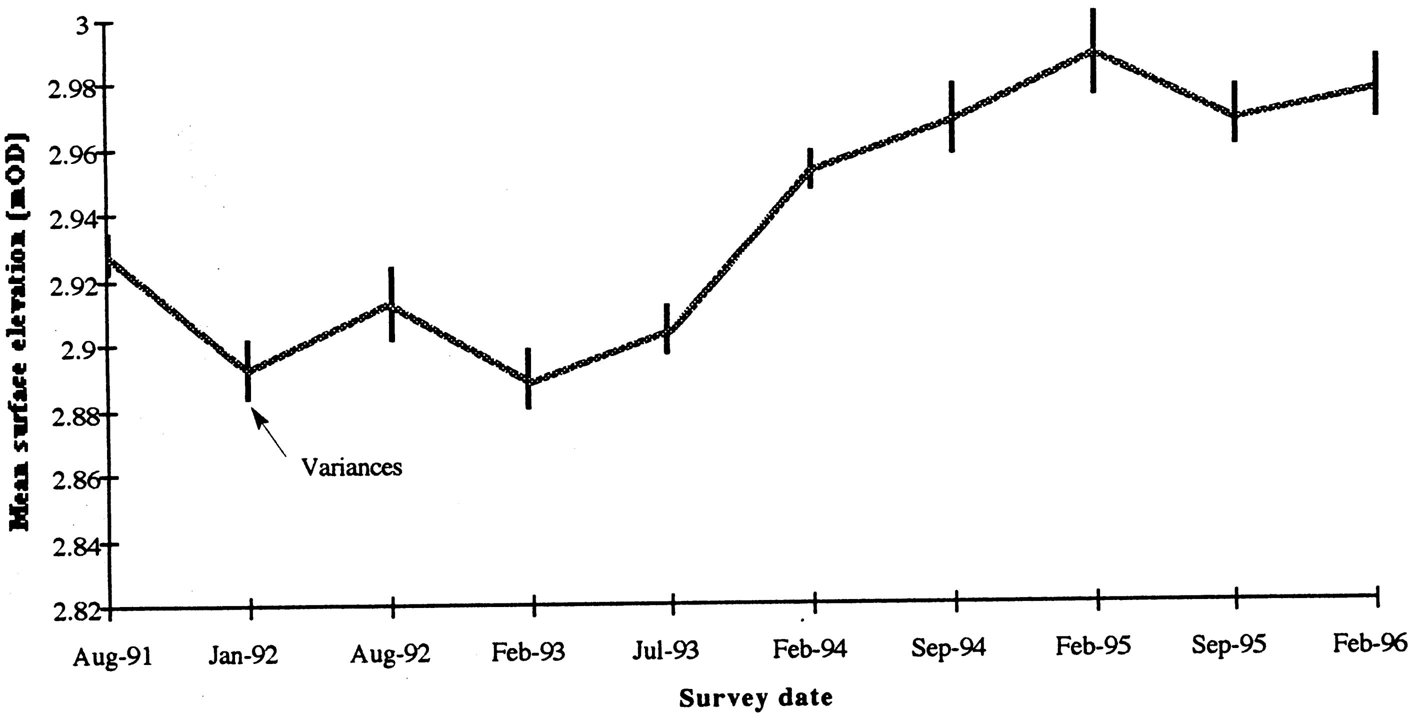

Figure 1	**Institute of Estuarine and Coastal Studies**
Changes in mean surface elevation (August 1991 to February 1996)	**University of Hull**

present. This stability, reached less than five years after the breach, would be expected given that the site is relatively high in the tidal frame.

The patterns observed in the statistical findings are expected, with the most significant results attained in February 1995 when the elvation was at its highest. This was followed by a fall in the significance of the results in September 1995 when the elevation decreased, and a further rise in t-values with the subsequent slight increase in elevation in February 1996.

2.2. Accretion

The results of the accretion measurements are presented in Appendix 2, with the latest set compiled into figure 2 (along the transect through the spillway) and figure 3 (random plates across the site). Of the transect measurements only those at the lower end of the mudflat are still relocatable, and show a continuation of trends previously observed, i.e. erosion over the lowest plate adjacent to the channel, stability on the second plate and continued accretion over all others. This will result in further overall steepening of the mudflat profile as observed in report 5. Since measurements could not be obtained from any of the transect plates on the marsh (due to corrosion - see report 5) it is not possible to draw conclusions about accretion in this area. However, since previous measurements indicated both erosion and accretion, and the topographic data suggests a period of stability, it may be suggested that no substantial changes have occurred in the accretion patterns.

Of the 11 random accretion plates installed across the marsh surface in February 1994 measurements were obtained from nine on this occasion, although two may only be regarded as tentative measurements (plates 7 and 10). As on previous occasions a high degree of variability may be observed, with both erosion and accretion occurring, although only in very small amounts which may be within the experimental error. The most noticeable pattern to emerge is the reversal of most of the measurements, i.e. those plates where accretion was observed in winter 1995 had experienced erosion by winter 1996, and *vice versa*.

Table 3 summarises the long term trends in annual accretion rates in the three sets of measurements.

Table 3. Annual accretion on the mudflat and marsh transect and the random marsh points

	Jan 92 - Feb 93	Feb 93 - Feb 94	Feb 94 - Feb 95	Feb 95 - Feb 96
Mudflat (transect)	4.125 cm	4.125 cm	1.43 cm	1.92 cm
Marsh (transect)	0.552 cm	0.071 cm	-	-
Marsh (random)	-	-	0.003 cm	0.001 cm

This shows the continued trends, with a reduced rate of accretion on the mudflat after the initial high rates, and very low accretion rates (approximating to no net accretion) on the marsh.

2.3. Sediments

In previous years surface sediment samples were obtained on each survey occasion, four from adjacent to the transect and a further 10 distributed across the marsh. During this monitoring

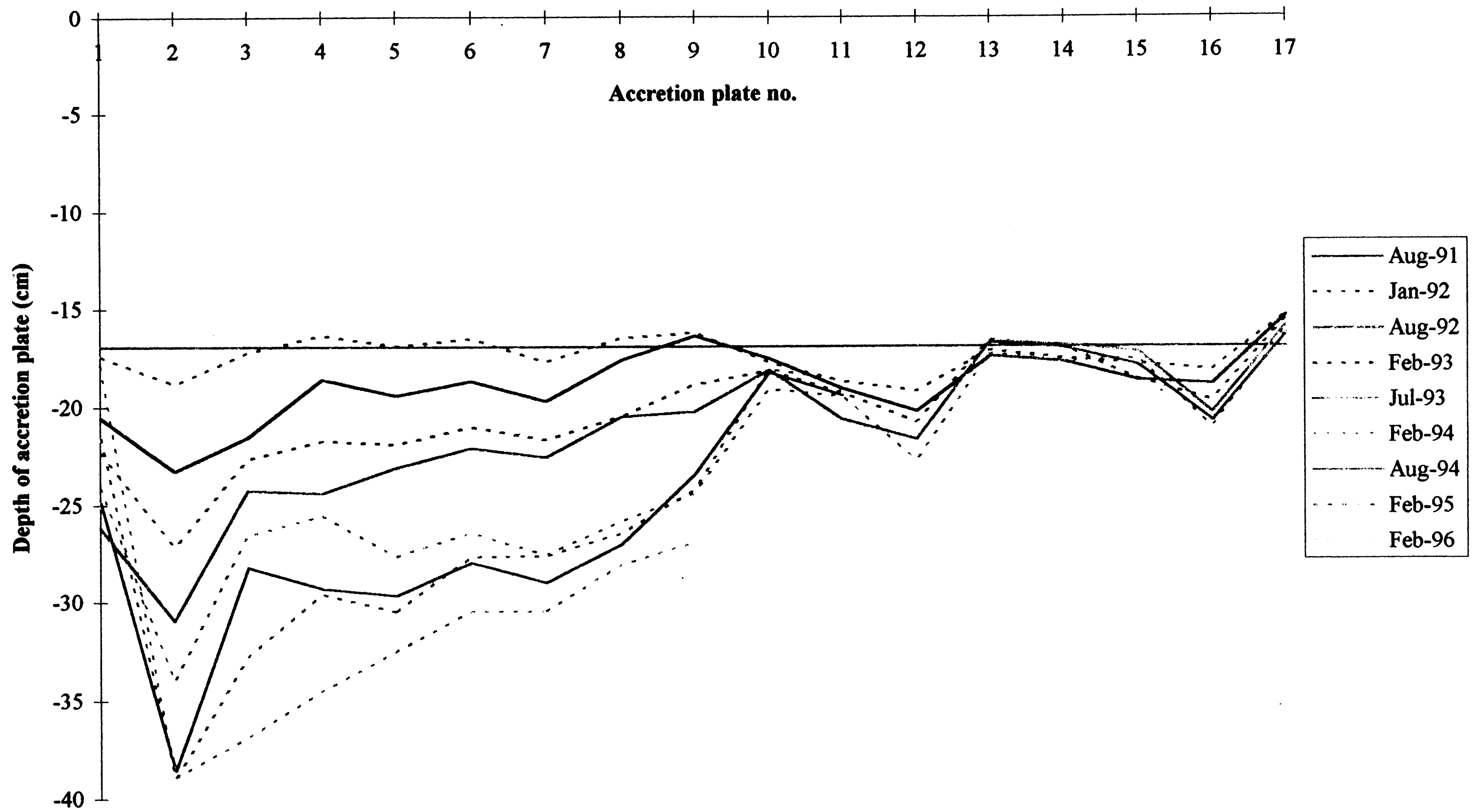

Figure 2	Institute of Estuarine and Coastal Studies University of Hull
Changes in the depth of accretion plates over each survey period since implementation of the managed retreat	

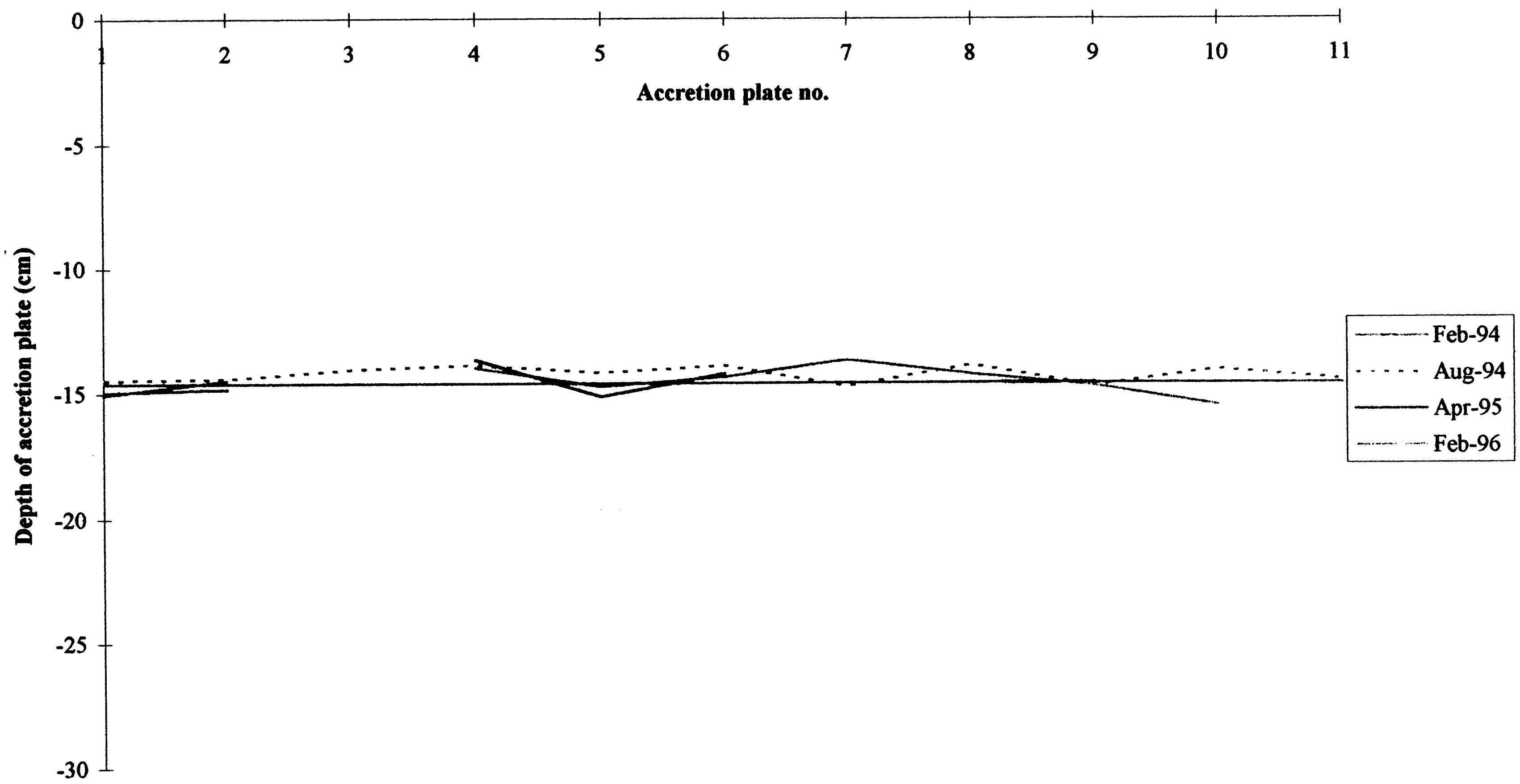

Figure 3

Changes in the depth of random accretion plates on marsh surface since installation in February 1994

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campaign it had been decided to take samples only during the winter period. The sediment samples are returned to the laboratory and the grain size characteristics analysed. The full results of these analyses are given in Appendix 3.

The spatial patterns of mean grain size are shown in figure 4. This shows very little variability in grain size across the site, all sediments being very similar and smaller than in previous years, with slightly coarser sediments generally located towards the upper end of the site. This could be the result either of storm deposits reaching the upper areas, or coarser sediments being washed from the internal walls.

2.4. Development of drainage topography

There has been further incision of the channel in the spillway into the site as shown in plate 3, but as plate 4 shows there is still some distance between the head of this channel and the area of standing water. Several more years may therefore be required before the channel eventually cuts into the pond and allows better drainage of this end of the site. All standing water areas have now been present for sufficient time to become well-established with no vegetation colonisation and increasingly well-defined sides. Thus it may be expected that even when the channel reaches the pond there will be significant differential flows through this area which may continue to prevent vegetation colonisation.

At the upper end of the site there remain the additional areas of standing water along the line of the inner borrow pit and in the large shallow pond behind. By 4.5 years after implementation, therefore, it may be concluded that the drainage topography has not developed satisfactorily, and has resulted in a significant proportion of the site being covered by standing water. As stated in report 4, these results tend to confirm experience from the United States which showed that relying on natural processes of erosion and accretion to establish drainage patterns took a very long time, particularly where the sediment is consolidated as on Northey Island. Also of relevance was the fact that sites filled with dredged material to a high level relative to the tidal frame tended to take longer to develop a drainage system by erosion than low sites which developed by differential accretion. The Northey Island site may be considered to represent a relatively high marsh which is relying on erosion to provide ebb drainage, and this is clearly only happening very slowly. At this stage, therefore, there is a temptation to speed the process by cutting the spillway channel into the first standing water area and observing any further changes which may occur. Although previously this has been resisted it is suggested that this action may now be appropriate.

2.5. General observations

The patterns of vegetation colonisation are apparently similar to those of the previous year, with *Salicornia* covering the majority of the site, although with increasing species diversity across much of the site as the primary coloniser (*Salicornia*) is out-competed by other species. *Spartina* is also becoming increasingly frequent particularly at the lower, eastern end of the site.

The upper areas are now colonised by a diverse and vigorous plant cover, notably along the western end of the site and along the levee which remains of the original inner sea wall. *Salicornia* has continued to colonise the original fronting sea wall as shown in plates 1 and 2, although the front edge is still subject to erosion which has prevented colonisation as seen in

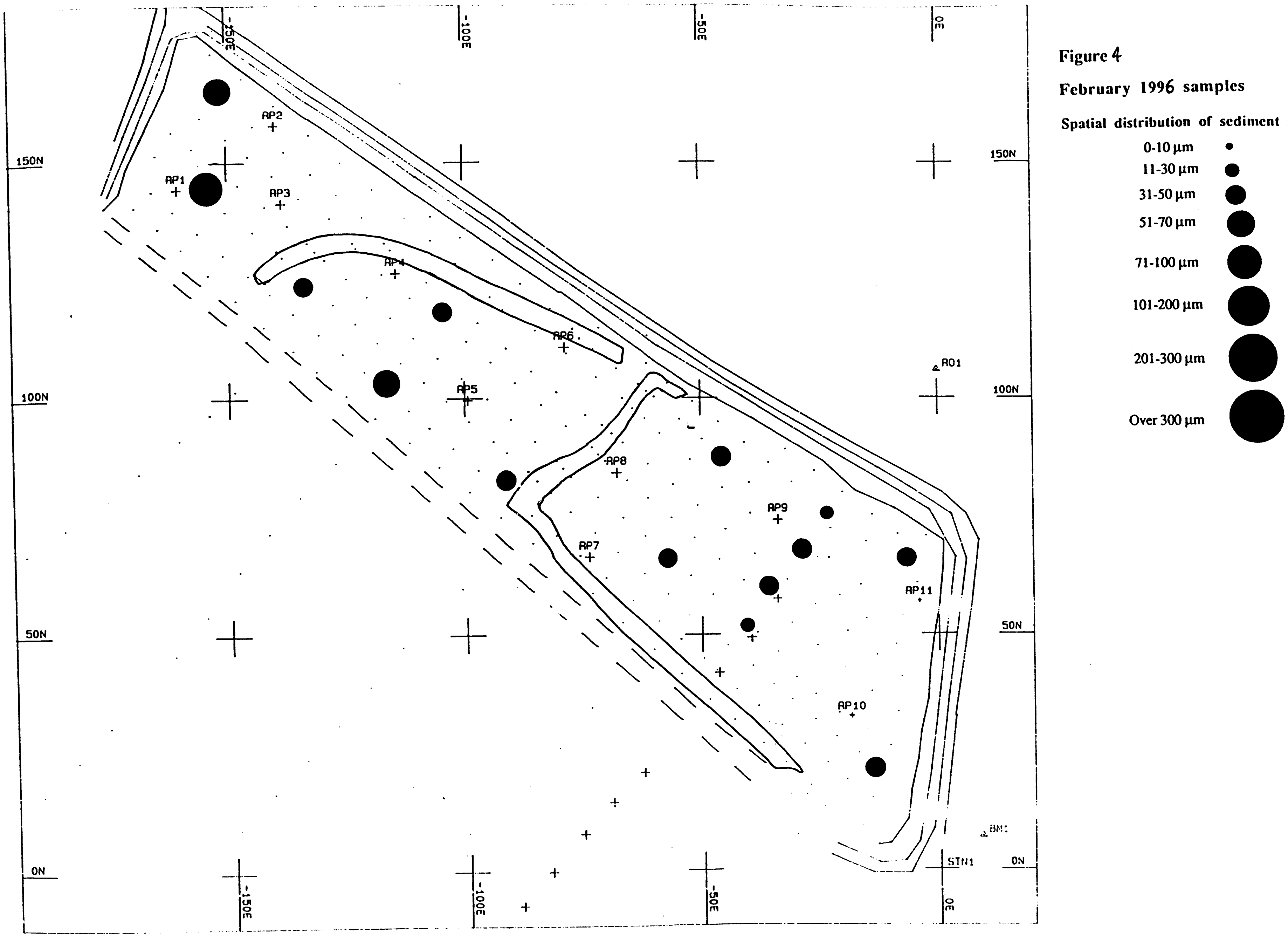


Figure 4

February 1996 samples

Spatial distribution of sediment sizes

plate 2. The extent of this erosion may be seen in relation to the original blockwork which remains along the front of the wall.

The erosion the back wall at the head of the middle creek does not appear to have deteriorated significantly since the previous survey, possibly as a result of the dense vegetation cover which has now established on this wall (see plate 5).

3. CONCLUSIONS

The main conclusion which may be drawn from this latest set of surveys is that very little has changed compared to the previous years. It appears that the topography may have reached a period of relative stability after 4.5 years, suggesting that any further changes will be in response to changes in the tidal regime. This stability is confirmed by the accretion measurements which show very little net accretion on the marsh surface, although the mudflat is continuing to accrete on its upper portions and erode towards the main channel. It is likely that the relative elevation of this site in the tidal frame has allowed a stable surface to be reached in the short time since implementation of the scheme. It may be suggested, therefore, that sites with a lower surface at the time of the breach would take proportionally longer to reach stability.

Vegetation colonisation is continuing, although the standing water areas now constitute a significant proportion of unvegetated surface on this relatively small site. In previous years it has been suggested that this site should be allowed to develop naturally, and would thus provide a comparison with the results on more experimental sites such as Tollesbury. However, at this stage it is possible that the site would benefit from a minor intervention in the form of completing the incision of the spillway channel into the first area of standing water.

Results from monitoring to date, and the conclusions from the American work, suggest that an appropriate drainage pattern will take a very long time to develop, if ever. There would therefore be an advantage in speeding the natural process of headward erosion which is occurring in the spillway, such that at least one area of ponding may be more effectvely drained. Although this is unlikely to affect drainage of the inner areas, possibly even that of the middle channel, observation of the results of this work may enhance our understanding of the system. Resistance of this natural inclination to speed a slow geomorphological process may also be appropriate, but it is suggested that the possibilities should be discussed at this stage.

4. PHOTOGRAPHS

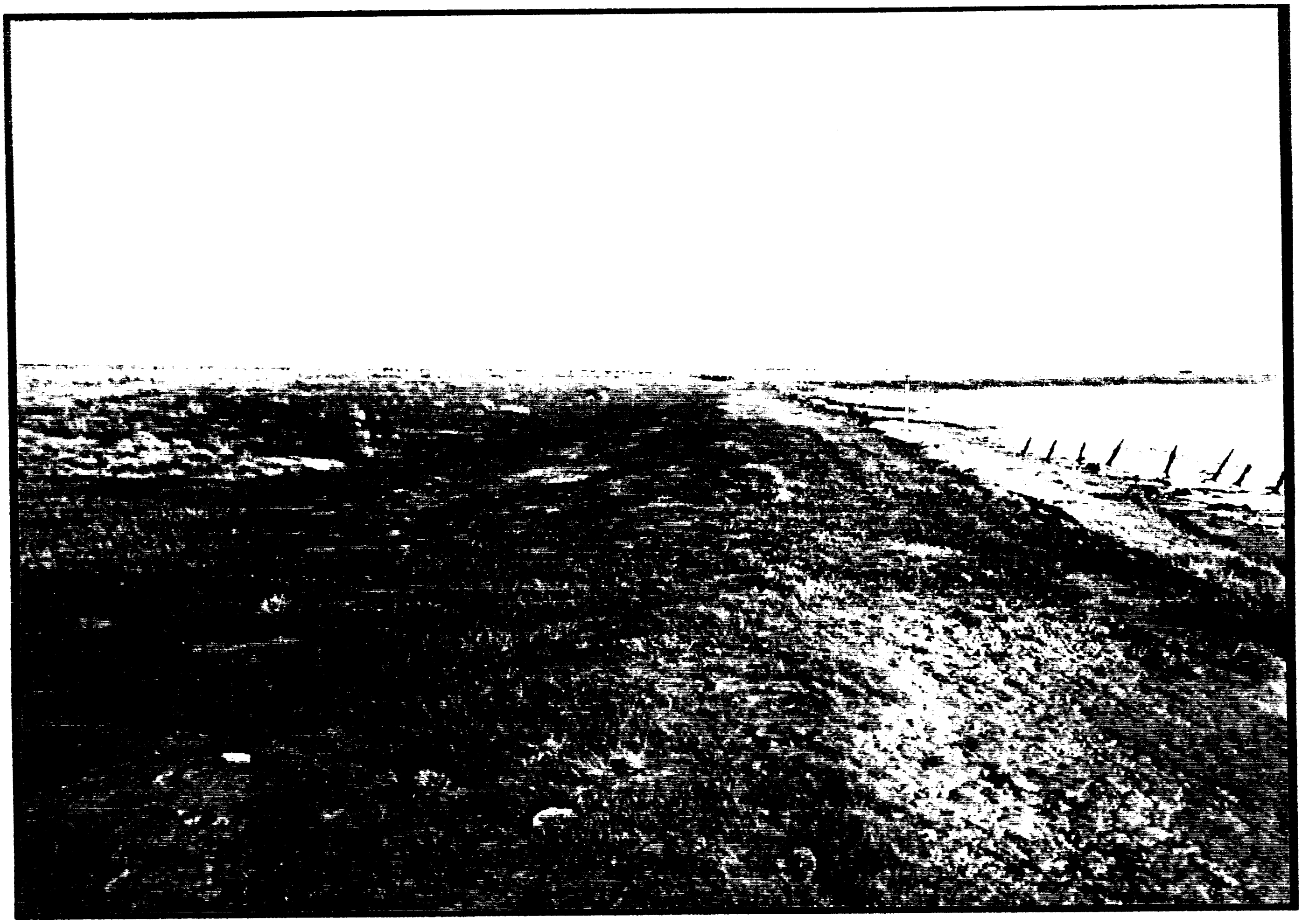


Plate 1. February 1996: Showing degree of colonisation along front wall

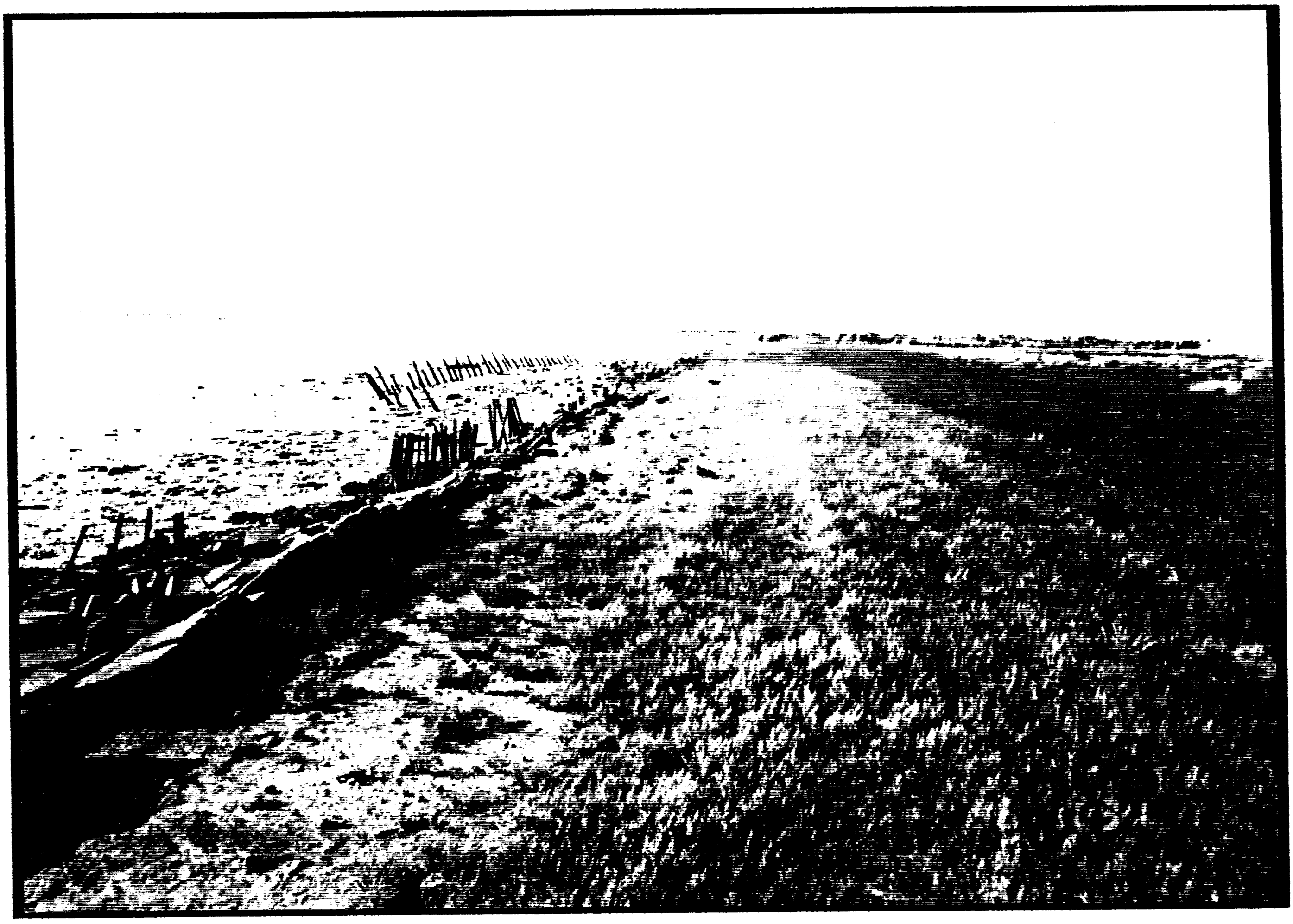


Plate 2. February 1996: From east end of site showing erosion behind original blockwork

Plate 3. February 1996: Further incision of spillway channel

Plate 4. February 1996: Note distance remaining between incised channel and standing water areas

Plate 5. February 1996: Channel across middle of site

Plate 6. February 1996: Vigorous vegetation along inner borrow pit and large ponded area behind

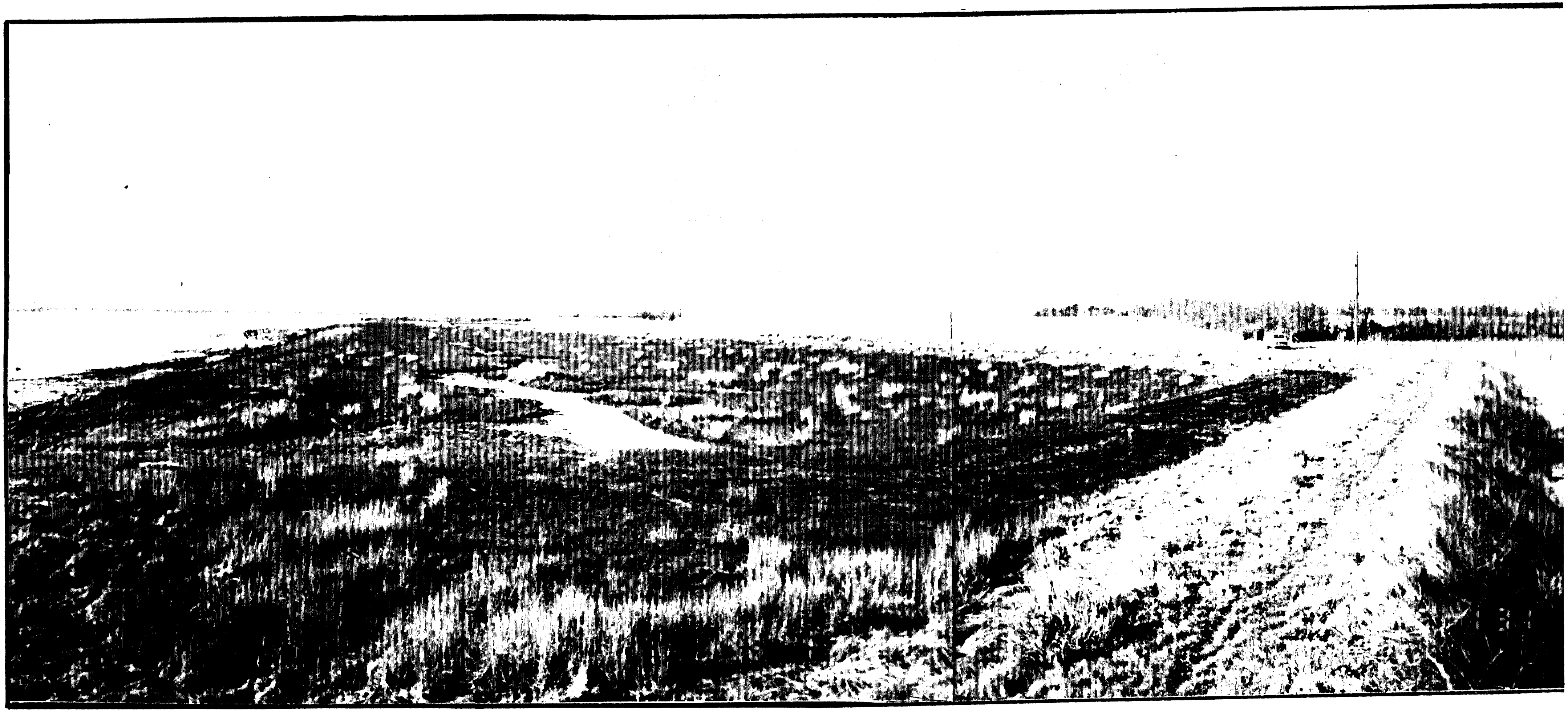


Plate 7. February 1996: General view across site looking west from spillway corner

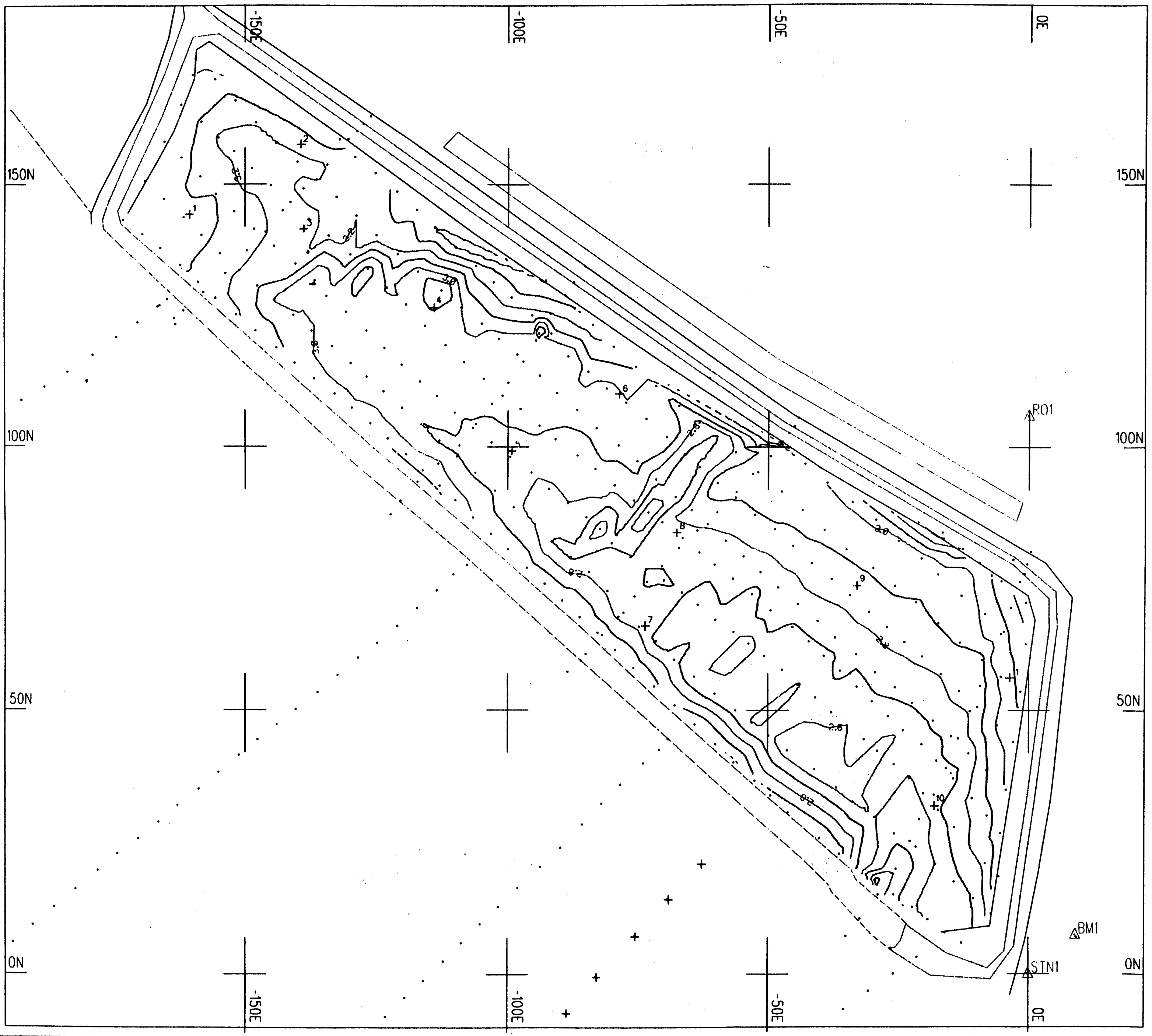
5. APPENDICES

Appendix 1: Contour maps (September 1995 and February 1996)

Appendix 2: Depth of accretion plates (August 1994 to February 1996)

Appendix 3: Sediment characteristics

Appendix 1. Topographic contour maps



LEGEND

- Sea Wall Base
- Sea Wall Top
- Sluice Cutting
- New Borrow Ditch
- Former Sea Wall
- Marsh Edge
- \+ Accretion Plate
- · Survey Point

Northey Island Survey 1.9.95

SCALE 1 : 750

CONTOUR INTERVAL 0.1m

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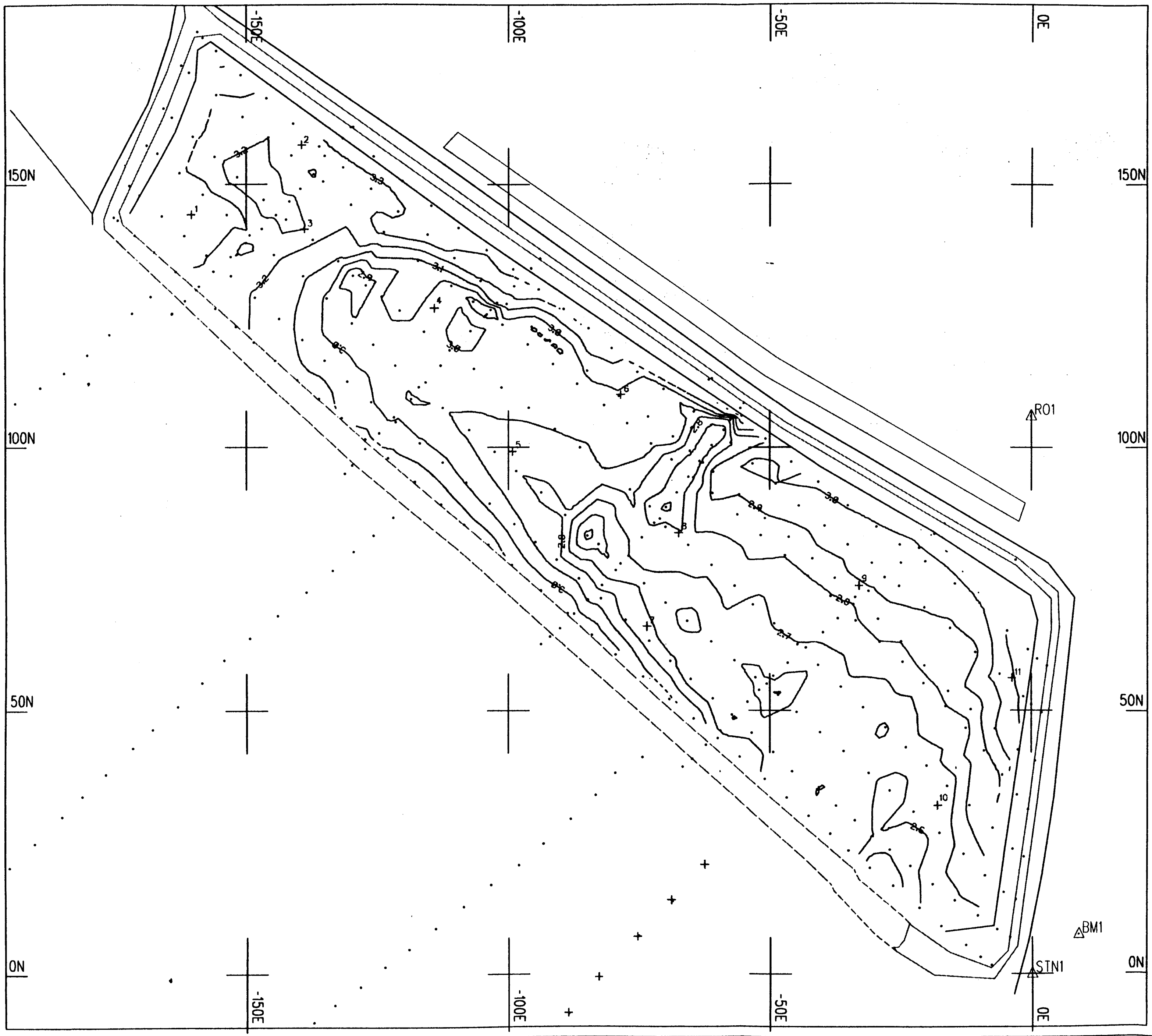

LEGEND

- Sea Wall Base
- Sea Wall Top
- Sluice Cutting
- New Borrow Ditch
- Former Sea Wall
- Marsh Edge
- Accretion Plate
- Survey Point

Northey Island Survey 30.1.96

SCALE 1 : 750

CONTOUR INTERVAL 0.1m

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Appendix 2. Depth (cm) of accretion plates

Accretion plate no.	Depth in August 1994	Depth in February 1995	Depth in February 1996
PAC1	-27.04	-23.72	-20.00
PAC2	-39.78	-40.22	-40.16
PAC3	-28.19	-32.70	-36.82
PAC4	-30.84	-31.14	-36.04
PAC5	-29.37	-30.18	-32.20
PAC6	-29.56	-29.26	-32.06
PAC7	-30.20	-28.80	-31.66
PAC8	-27.98	-27.40	-29.04
PAC9	-24.12	-24.90	-27.60
PAC10	-13.02	-12.86	
PAC11	-10.89	-10.08	
PAC12	-23.63	(standing water)	
PAC13	-15.75		
PAC14	-21.87		
PAC15	-18.43		
PAC16	-19.87		
PAC17	-17.27		

Additional random accretion plates installed February 1994

	February 1994	August 1994	February 1995	February 1996
RND1	-16.02	-15.87	-16.36	-16.46
RND2	-15.14	-14.92	-15.34	-15.00
RND3	-18.06	-17.48		
RND4	-17.22	-16.46	-16.26	-16.58
RND5	-15.12	-14.68	-15.66	-15.26
RND6	-16.22	-15.51	-15.84	-15.96
RND7	-12.28	-12.42		-11.36 (?)
RND8	-14.20	-13.46	-14.20	-13.86
RND9	-11.86	-11.98	-11.82	-11.98
RND10	-14.28	-13.73		-15.18 (?)
RND11	-10.22	-10.06		

Missing values represent accretion plates which could not be relocated due to severe corrosion

Appendix 3. Sediment characteristics

Summary of Particle Size and Organic Carbon data for sediment samples from February 1996 survey

Sample	% Silt & Clay	Median Ø	Mean Ø	Sorting Coefficient	Median µm	Mean µm	Skew	% Organic Carbon	% LOI at 400¤C	% Coal
NI 1	89.57	6.03	5.06	1.68	15.31	30.00	0.017	5.91	13.22	4.65
NI 2	81.94	5.99	4.64	1.98	15.72	40.03	-0.089	11.43	15.44	5.95
NI 3	83.13	5.71	4.71	1.78	19.16	38.17	0.010	7.11	15.84	8.99
NI 4	89.63	6.04	5.15	1.66	15.22	28.21	0.024	7.11	20.24	1.11
NI RS 1	82.65	5.68	4.48	1.99	19.50	44.91	0.011	3.23	9.18	0.37
NI RS 2	83.41	5.65	4.43	2.01	19.89	46.30	0.029	0.40	6.34	3.64
NI RS 3	83.02	6.00	4.60	1.95	15.60	41.21	-0.114	8.90	27.38	2.86
NI RS 4	87.39	6.20	4.92	1.82	13.56	33.05	-0.097	10.51	13.72	2.29
NI RS 5	86.68	6.02	4.79	1.85	15.44	36.23	-0.053	4.48	15.75	2.21
NI RS 6	78.50	5.61	4.25	2.08	20.47	52.41	-0.026	2.80	10.00	5.11
NI RS 7	80.04	5.58	4.55	1.84	20.88	42.64	0.003	6.29	19.21	4.36
NI RS 8	86.10	6.04	4.75	1.92	15.24	37.08	-0.051	7.45	21.63	1.51
NI RS 9	67.46	5.12	3.75	2.30	28.78	74.47	-0.014	9.79	31.49	2.49
NI RS 10	69.83	5.00	3.93	2.12	31.33	65.40	0.083	11.66	26.69	2.77