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Assemblages from Norfolk: North Elmham Park, Happisburgh, St Anne's Lane, Norwich, and Bryant's Wharf, Great Yarmouth

Tree-ring Analysis of Archaeological Oak Samples

Ian Tyers

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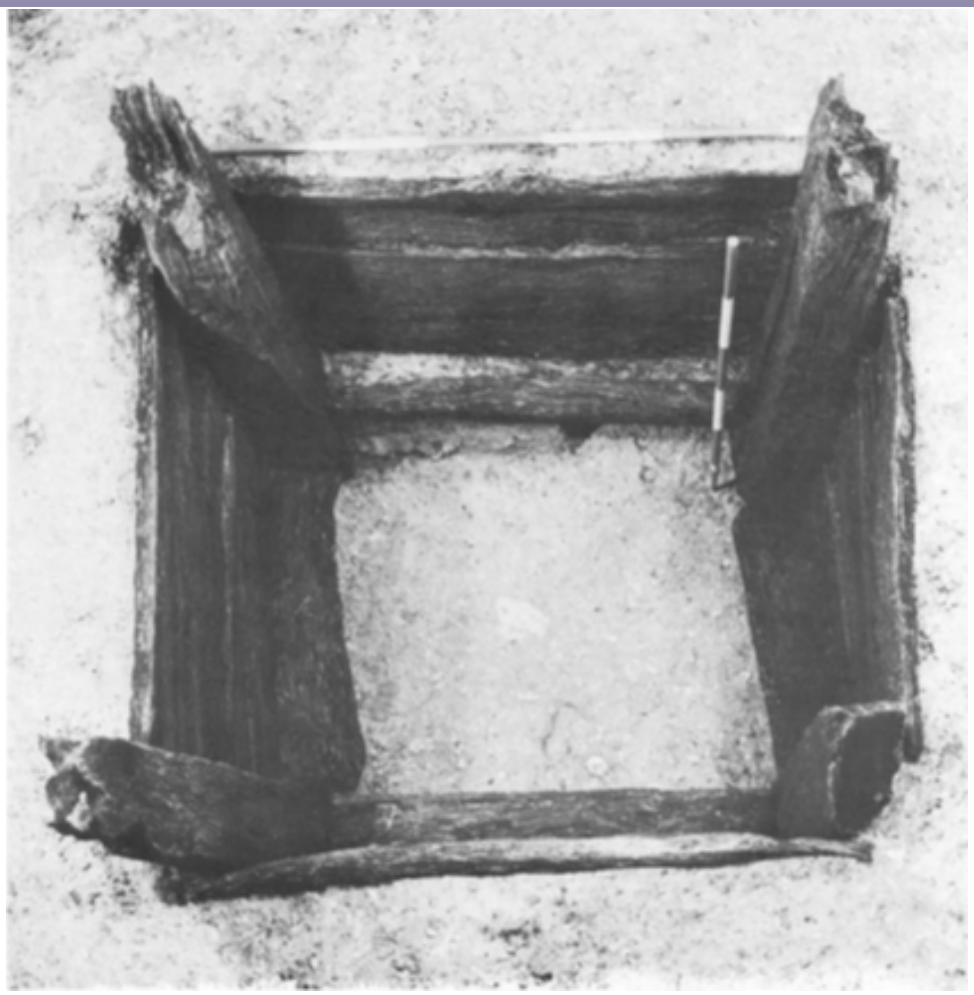

Research Report Series no. 8/2022

Front cover: Well II: a general view of the bottom of the well from the south,
North Elmham Park 1967-72. Plate XXXIX. Photo by Marius Cooke.

Research Report Series 8/2022

ASSEMBLAGES FROM NORFOLK: NORTH ELMHAM PARK, HAPPISBURGH, ST ANNE'S LANE, NORWICH, AND BRYANT'S WHARF, GREAT YARMOUTH

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SUMMARY
In response to the Norfolk Museum Service Wood Storage Rationalisation Project, a dendrochronology assessment was commissioned by Historic England on a number of excavated timbers from North Elmham Park, Happisburgh, and St Anne's Lane in Norwich and Bryant's Wharf in Great Yarmouth, prior to their disposal from long-term storage at Gressenhall Museum. The North Elmham Park samples had been analysed by John Fletcher in the early 1970s but had not successfully dated.

CONTRIBUTOR
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Heather Wallis and the late Richard Darrah curated the samples at Gressenhall Museum near Dereham. I am grateful to Heather for her assistance in accessing the material. My thanks to the Managing Editor of East Anglian Archaeology for permission to reproduce figures used in this report. At Historic England, Will Fletcher, Inspector of Ancient Monuments and Shahina Farid, Scientific Dating Team, are thanked for commissioning and facilitating this programme of dendrochronological analysis.

ARCHIVE LOCATION
The Historic England Archive, The Engine House, Fire Fly Avenue, Swindon, SN2 2EH

HISTORIC ENVIRONMENT RECORD
Norfolk Historic Environment Record, The Archive Centre, Martineau Lane, Norwich, NR1 2DQ

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CONTENTS

INTRODUCTION

This document is a technical archive report on the tree-ring analysis of oak samples from four sites in Norfolk (Fig 1). These samples were selected during a storage rationalisation project by Norfolk Museums Service (NMS). Duplicate samples were retained by NMS. It is beyond the dendrochronological brief to describe these excavations in detail, but elements of this report may be combined with detailed descriptions, photographs, and other technical reports at some point in the future to form either a comprehensive publication or an archive deposition on this material.

METHODOLOGY

Samples were provided as separately bagged and labelled cross-sections. When excavated this material would have been waterlogged but by the time of this analysis the material was dry, and prone to cracking. Some sapwood survived, but much more had probably disintegrated during storage.

Tree-ring dating employs the patterns of tree-growth to determine the calendar dates for the period during which the sampled trees were alive. The amount of wood laid down in any one year by most trees is determined by the climate and other environmental factors. Trees over relatively wide geographical areas can exhibit similar patterns of growth, and this enables dendrochronologists to assign dates to some samples by matching the growth pattern with other ring-sequences that have already been linked together to form reference chronologies.

Timbers intended for dendrochronological analysis need to be free of aberrant anatomical features such as those caused by physical damage to the tree, which may prevent or significantly reduce the chances of successful dating.

Standard dendrochronological analysis methods (see eg English Heritage 1998) were applied to each suitable sample from each site. Complete or partial sequences of the annual growth rings were measured to an accuracy of 0.01mm using a micro-computer based travelling stage (Appendix 1). The sequences of ring widths were then plotted onto semi-log graph paper to enable visual comparisons to be made between sequences. In addition, cross-correlation algorithms (eg Baillie and Pilcher 1973) were employed to search for positions where the ring sequences were highly correlated. The ring sequences with highly correlated positions were, in addition, plotted on the computer screen, or onto semi-log graph paper, to allow visual comparisons to be made, this providing a measure of quality control identifying any potential errors in the measurements. Where such matching positions were satisfactory, new composite sequences were constructed from the synchronised sequences. Any *t*-values reported below were derived from the original CROS algorithm (Baillie and Pilcher 1973). A *t*-value of 3.5 or over is usually indicative of a good match, although this is with the proviso that high *t*-values at the same relative or absolute position need to have been obtained from a range of independent sequences, and that these positions were supported by satisfactory visual matching.

Not every tree can be correlated by the statistical tools or the visual examination of the graphs. There are thought to be a number of reasons for this, such as genetic variations, site-specific issues (for example, a tree growing in a stream bed will be less responsive to rainfall), or some traumatic experience in the tree's lifetime (such as injury by pollarding), defoliation events by caterpillars, or similar. These could each produce a sequence dominated by a non-climatic signal. Experimental work with modern trees shows that 5–20% of all oak trees, even when enough rings are obtained, cannot be reliably cross-matched.

Converting the date obtained for a tree-ring sequence into a useful date requires a record of the nature of the outermost rings of the sample. If bark or bark-edge survives, a felling date precise to the year or season can be obtained. If no sapwood survives, the date obtained from the sample gives a *terminus post quem* for its use. If some sapwood survives, an estimate for the number of missing rings can be applied to the end-date of the heartwood. This estimate is quite broad and varies by region. This report uses 15 rings as the minimum sapwood estimate for the Irish timber from Great Yarmouth, based on comparative data from Irish trees (Brown pers. comm.), and a range of 10–46 rings for the local English material from North Elmham (English Heritage 1998, 11; Arnold *et al* 2019, fig 9)

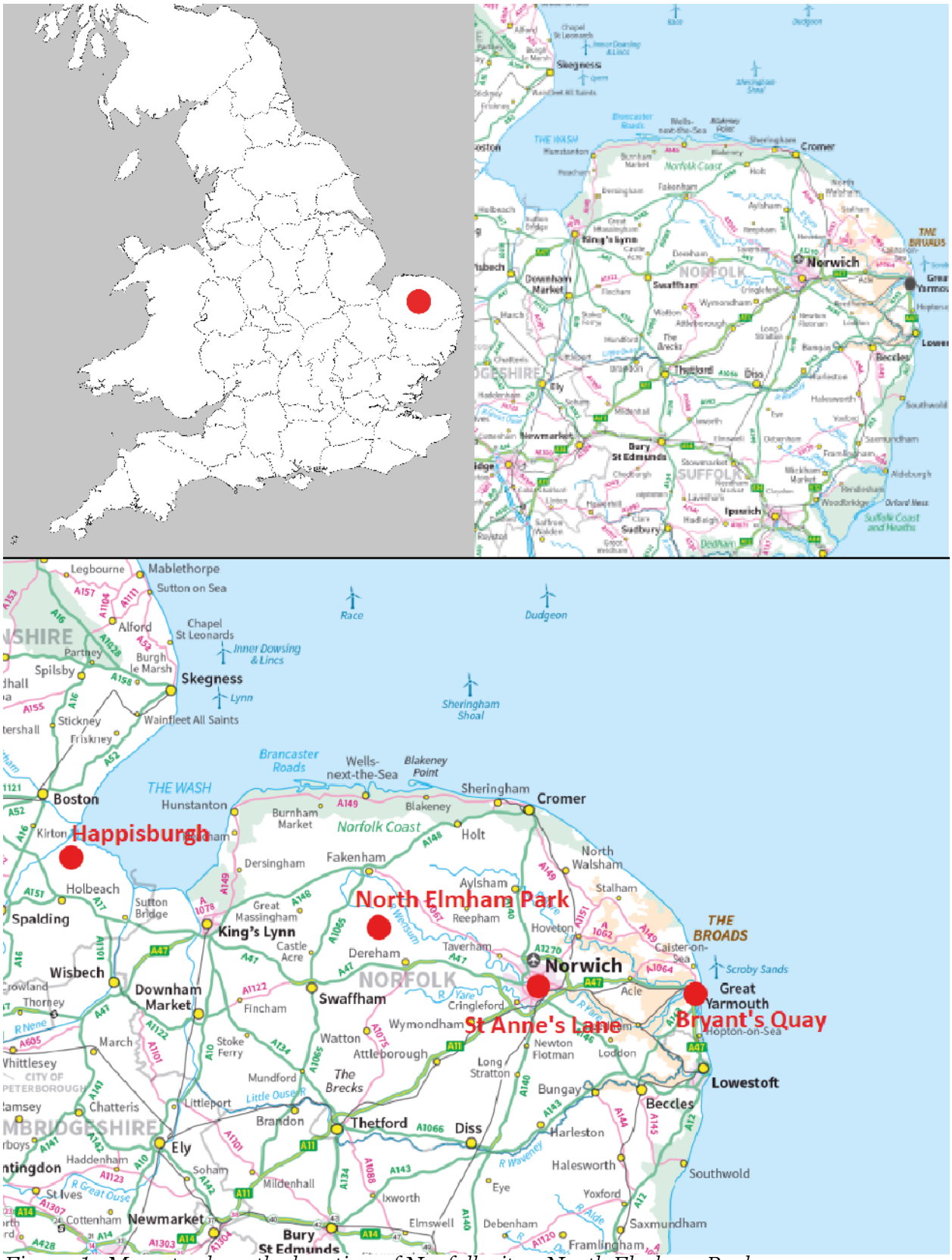


Figure 1: Maps to show the location of Norfolk sites, North Elmham Park, Happisburgh, St Anne's Lane, and Bryant's Quay (red dots). Scale: 1:850,000. © Crown Copyright and database right 2024. All rights reserved. Licence number 100024900

NORTH ELMHAM PARK 1967–72

Excavations between 1967 and 1972 revealed an extensive Middle Saxon and Late Saxon settlement (NHER:1013; TF 9869 2142; Fig 2). Two timber-lined wells were recorded at the southern end of the site, approximately 12m apart (Fig 3). These were dated to the eighth to ninth centuries. Well I apparently preceded the earliest of the boundary ditches, and Well II cut through the foundation trench of a building. Well I, located in1967, was sunk through the boulder clay into the underlying sand to a depth of almost 12m and Well II, discovered in 1971, was a 6.3m deep cistern for collection of surface water (Fig 4).

A total of 46 samples were provided, labelled 1–46, with some identifiers that are presumed to relate to the excavation records. All these samples are from Well II (Heather Wallis pers comm; Wade-Martins *et al* 1973, *25; figs 96–108*; *pl XXXIII–LV*; Wade-Martins 1980) After preparation it was found that 44 were suitable for analysis (Table 1). The unsuitable samples, numbered 37 and 41, are not further discussed here. Images in Wade-Martins (1980) suggest Well II comprised 10 to 12 rows of horizontal boards on each of the 4 sides, and 4 corner posts. This suggests these samples probably comprise each of the excavated timbers.

All of the sequences recorded from this material cross-match (Tables 2–4). Many of the planks appear to be derived from a relatively small number of individual long-lived trees, for example, samples 1, 3, 4, 6–18, 20, 21, 24–7, 29, 31–4, 36, 38, and 43–5 could be from a single tree, or a closely associated set of trees. Others were of different characteristics, such as, sample 5 contains only a short sequence, whilst samples 35, 39, 40, and 42 were distinctly different in their size, their growth rate and their cross-matching, although they were clearly contemporaneous. It seems possible these latter samples were from the corner posts.

The individual series were unusually prone to changes in growth rate, perhaps a reflection of the free draining geology in the area. The earlier work from the site (Wade-Martins *et al* 1973; 1980) produced a tree-ring sequence that has not been proven to be datable during the subsequent development of an English tree-ring chronology across the Saxon period. However, there is now a more comprehensive range of middle-Saxon datasets for this period, although this period is still dominated by data from the South-East and East Anglia regions, and only one, relatively recent find is from Norfolk. A 214-year site composite constructed from the 44 newly measured samples can be absolutely dated to AD 572–785 inclusive (Table 5). This is a period with relatively little data from the midlands and northern parts of England. The Elmham sequence exhibits disappointingly weak matching to Great Ryburgh, which is geographically closest to those datasets, being about 6km to the north. This dating then dates the historical *Elmham* tree-ring sequence produced from a small subset of the same material analysed by John Fletcher in 1972. Figure 5 illustrates the relative positions of the 44 samples, and their individual interpretations using a 10–46 year sapwood estimate. Five of these samples have surviving sapwood, one has a piece of detached sapwood associated with it, and a further 21 samples end at the onset of, or probable onset of, sapwood. These end rings constrain the date of Well II to a date after AD 795, derived from the detached sapwood from sample 28, and before AD 805, derived from the sapwood estimate applied to sample 22, with sample 26 giving a date before AD 806 and samples 23, 36, and 46, giving a date before AD 808. A date within 5 years either side of AD 800 is therefore indicated for the construction of the structure found at the bottom of Well II.

Fletcher's 1972 analysis of six planks and two posts was undertaken whilst the material was still fresh. He successfully cross-matched five planks and a post.

Undoubtedly, he targeted samples with sapwood since all six of these series included some sapwood (Wade-Martins 1980, fig 103). These in combination yielded a sequence of 214 rings, assigned as arbitrary years 0–213. "*The years of sapwood on the five planks and north-east post are helpful in making an assessment of the Felling Year for the trees. This could not be before Arbitrary Year 214 because E 12 has sapwood for the Year 213*" Fletcher in Wade-Martins (1980, 96).

We can now demonstrate that the original *Elmham* sequence dated from AD 579–792 (Fig 5), and therefore Fletchers interpretation provides a date after AD 793 for Well II. He then constrains it to AD 795 by using a hypothetical maximum thickness of sapwood, a technique no longer considered reliable for English material.

The unusual sensitivity of this material during the initial decades of growth are apparent at the left end of Figure 6. The original and new datasets are closely similar throughout except for a very narrow ring for AD 585, which was missed near the beginning of the original sequence. The individual ring-width series from Fletcher's analysis do not, as far as currently known, survive. It is not possible to identify which of the present samples are from the same timbers. Fletcher's dated planks are labelled as East 11, East 12, North 9, West 11, and West 12, along with the north-east post. The original data set was measured using a x10 eyepiece, and will have had a 0.1mm resolution, at best.

The end of Fletcher's discussion of Well II (*ibid* p100) includes a note "*(Note added at proof stage, February 1979: Our comparisons with various contemporary continental and English sequences have not yet provided a reliable dating for this North Elmham sequence. Tentative matching with planks of the Graveney ship (Fletcher, Tapper and Walker 1978) has given the most reliable agreement so far.)*". The new data does not support any match to Graveney. It appears likely that North Elmham Park Well II has produced an extremely localised dataset of limited use for dating material from this period in any other parts of the country.

Table 1: Details of the analysed oak samples from North Elmham Park, Well II

#	Other identifier	Dimensions (mm)	Rings	Sapwood	AGR (mm)	Date of measured sequence	Interpreted result
1	A4229	300 x 50	197	9	1.50	AD 590-786	AD 787–823
2		165 x 50	142	-	1.16	AD 609-750	after AD 760
3	A4235	200 x 40	149	?H/S	1.37	AD 619-767	AD 777–813?
4		160 x 55	138	-	1.12	AD 620-757	after AD 767
5	A3476	100 x 25	63	-	1.54	AD 691-753	after AD 763
6	A3479	130 x 15	112	-	1.18	AD 634-745	after AD 755
7	A4228	185 x 55	143	?H/S	1.28	AD 630-772	AD 782–818?
8	A4275	145 x 30	101	-	1.44	AD 655-755	after AD 765
9		150 x 30	133	-	1.12	AD 611-743	after AD 753
10	A3487	235 x 60	197	?H/S	1.17	AD 572-768	AD 778–814?
11	A4233	275 x 40	176	2	1.53	AD 605-780	AD 788–824
12	A3485	265 x 35	202	9	1.31	AD 582-783	AD 784–820
13	A4236	215 x 35	154	-	1.33	AD 618-771	after AD 781
14	AS12363	235 x 40	178	1	1.31	AD 603-780	AD 789–825
15	A4232	190 x 45	149	-	1.21	AD 612-760	after AD 770
16	A4231	210 x 40	168	?H/S	1.24	AD 599-766	AD 776–812?
17		130 x 25	118	-	1.07	AD 629-746	after AD 756
18	A4230	225 x 55	169	?H/S	1.35	AD 607-775	AD 785–821?
19	A4254	155 x 35	134	-	1.11	AD 629-762	after AD 772
20		140 x 25	137	-	1.02	AD 618-754	after AD 764
21	A4249	225 x 65	183	?H/S	1.17	AD 586-768	AD 778–814?
22		150 x 75	98	H/S	0.83	AD 662-759	AD 769–805
23		170 x 80	97	H/S	1.14	AD 666-762	AD 772–808
24		230 x 35	170	?H/S	1.35	AD 599-768	AD 778–814?
25	A4692	225 x 50	166	?H/S	1.30	AD 601-766	AD 776–812?
26	A4237	165 x 60	171	?H/S	0.94	AD 590-760	AD 770-806?
27	A4239	225 x 30	162	-	1.31	AD 599-760	after AD 770
28	A3489	380 x 50	182	H/S+*20*	1.16	AD 594-775	AD 795–821
29	A4689	255 x 85	193	?H/S	1.21	AD 580-772	AD 782–818?
30		80 x 60	91	-	0.79	AD 658-748	after AD 758
31	A4690	255 x 75	193	?H/S	1.28	AD 582-774	AD 784–820?
32	A4226	180 x 55	160	?H/S	1.07	AD 607-766	AD 776–812?
33	A4688	220 x 50	161	?H/S	1.33	AD 609-769	AD 779–815?
34	A4691	195 x 40	155	?H/S	1.23	AD 612-766	AD 776–812?
35	A4390	300 x 170	81	-	3.65	AD 680-760	after AD 770
36		160 x 80	171	?H/S	0.90	AD 592-762	AD 772–808?
38		215 x 70	155	?H/S	1.41	AD 614-768	AD 778–814?
39	AS12362	255 x 145	131	-	1.97	AD 646-776	after AD 786
40	AS12364	230 x 170	108	-	2.21	AD 660-767	after AD 777
42	A4303	245 x 125	120	-	2.09	AD 654-773	after AD 783
43	A4301a	300 x 35	179	2	1.63	AD 598-776	AD 784–820
44	A4301b	240 x 35	184	?H/S	1.29	AD 595-778	AD 788–824?
45	A4269	280 x 55	192	?H/S	1.48	AD 578-769	AD 779–815?
46	A4274	140 x 65	101	H/S	0.75	AD 662-762	AD 772–808

KEY: ?H/S possible onset of sapwood; H/S onset of sapwood; *+20* estimated number of rings in detached sapwood; AGR = average growth rate per year

Table 2: t-*values between sequences 1–22 from North Elmham Park.* – t-*values less than 3.0.*

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	6.65	12.29	10.82	3.76	9.73	10.18	10.19	14.54	17.23	10.51	15.21	10.90	13.83	13.40	14.53	12.63	12.59	5.46	9.91	13.31	4.65
2		4.86	5.85	-	6.54	11.83	4.23	6.96	7.05	11.11	8.53	7.66	10.69	6.95	4.74	6.56	10.50	-	5.44	7.76	3.72
3			10.81	4.27	9.98	5.71	14.93	8.12	9.64	7.06	10.51	10.06	10.13	12.15	9.87	8.83	9.07	11.58	8.33	10.06	4.61
4				3.88	5.81	6.25	6.94	8.27	7.49	7.68	9.64	8.37	9.88	7.90	6.69	8.15	8.29	6.29	7.24	12.22	5.83
5					4.09	-	4.77	-	3.02	-	-	3.88	-	3.52	4.25	3.88	3.50	5.04	-	-	-
6						6.98	7.86	11.39	9.17	8.24	9.21	6.73	9.75	18.50	11.05	12.89	10.53	6.26	9.71	8.54	5.07
7							4.42	7.05	8.57	11.46	9.49	6.58	9.74	6.45	6.23	7.58	11.43	-	6.50	8.05	4.27
8								5.37	8.76	6.54	8.40	7.71	7.07	8.18	7.52	7.06	7.18	8.95	7.92	7.40	3.66
9									12.72	10.56	14.41	7.72	16.36	15.84	16.67	14.98	12.02	4.32	11.86	12.41	5.52
10										11.75	15.57	8.71	12.44	11.60	11.70	11.79	14.01	4.80	8.22	12.85	3.69
11											13.90	9.24	15.54	8.69	8.45	11.26	13.26	4.05	8.39	10.55	4.79
12												9.78	19.55	13.60	14.29	11.56	13.86	5.73	12.23	16.36	5.85
13													11.50	9.18	7.20	7.36	8.92	6.08	8.50	8.89	4.66
14														13.81	12.84	13.96	14.37	5.74	13.09	14.08	5.35
15															15.41	14.26	11.50	6.92	11.20	12.24	5.07
16																15.76	9.92	4.81	12.32	10.66	3.79
17																	12.31	4.79	10.17	9.89	3.97
18																		4.85	8.62	10.94	5.44
19																			4.47	7.49	3.36
20																				9.48	4.98
21																					5.77

Table 3: t-*values between sequences 1–22 and sequences 23–46 (except 37 & 41) from North Elmham Park –* t-*values less than 3.0*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
23	7.06	6.72	6.61	6.17	4.56	6.93	6.69	6.80	5.50	7.42	9.07	7.92	6.10	9.05	6.73	6.59	8.00	10.90	5.55	5.87	7.39	7.24
24	11.95	7.44	11.42	9.66	4.53	8.44	7.03	11.67	11.66	12.93	9.89	14.42	13.72	14.80	13.23	10.80	9.47	14.43	7.33	9.52	10.90	4.51
25	15.24	8.26	12.14	9.78	5.43	11.89	8.67	8.85	13.40	11.10	9.55	13.53	10.54	14.99	12.30	10.99	13.69	12.94	6.27	11.40	10.28	4.21
26	9.61	9.71	6.31	7.47	-	6.27	8.36	4.99	8.72	9.52	11.74	9.85	6.88	13.08	8.75	7.99	8.12	8.84	3.72	7.11	8.55	4.30
27	11.35	5.30	17.01	8.99	3.96	9.42	6.11	12.14	10.50	10.66	7.74	14.01	8.29	10.34	13.06	10.00	7.91	10.96	11.91	8.22	12.26	4.42
28	6.50	4.78	3.72	3.84	-	4.73	5.78	-	6.85	5.75	4.59	5.84	4.10	6.07	6.95	6.87	5.91	7.44	-	4.92	7.05	-
29	14.70	7.37	10.52	14.34	-	7.07	7.79	7.08	12.02	14.09	9.94	14.47	9.35	14.10	9.09	9.83	10.26	9.86	6.26	8.47	17.84	5.38
30	3.90	4.79	3.90	4.52	-	3.68	3.21	3.23	3.30	3.99	5.65	3.74	5.72	6.21	3.51	-	3.74	4.09	-	3.29	4.28	4.51
31	17.46	8.89	8.96	13.68	3.43	8.36	8.06	5.98	13.89	15.19	12.34	18.13	9.12	15.90	10.14	11.07	10.97	11.38	4.38	9.50	16.42	4.48
32	11.64	7.85	7.96	7.92	-	9.30	11.97	7.49	9.72	9.50	7.94	10.96	7.63	12.42	9.81	8.80	10.30	11.14	3.69	9.64	11.14	5.30
33	12.40	5.18	14.20	7.87	3.79	8.76	5.07	12.74	9.58	10.35	7.83	11.44	9.17	11.53	13.18	10.36	7.70	10.26	8.65	7.97	10.25	4.17
34	13.53	5.77	11.70	8.29	3.84	7.70	5.86	9.38	11.72	9.53	9.07	12.26	8.73	13.49	14.21	14.33	11.51	9.72	5.72	9.34	10.16	4.02
35	-	-	-	-	4.79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
36	14.18	9.13	8.89	13.04	5.11	8.37	9.49	7.64	12.78	11.28	12.67	13.07	9.84	15.14	10.84	10.02	11.70	12.75	4.63	9.11	12.79	4.07
38	13.88	7.30	8.51	9.72	-	8.85	10.87	7.72	10.03	10.19	9.35	12.40	8.13	12.24	10.78	10.91	10.14	10.90	4.15	10.70	11.94	4.82
39	-	-	3.47	-	3.63	-	-	3.64	-	-	-	3.90	4.36	3.84	3.35	-	-	-	3.81	3.20	3.23	-
40	-	-	-	-	3.90	-	-	-	-	-	-	-	-	-	-	-	-	-	4.16	-	-	-
42	3.58	4.72	3.55	3.39	-	3.38	-	-	-	-	3.82	5.71	5.03	5.79	4.53	3.25	3.42	3.45	3.71	3.73	5.14	3.42
43	13.98	8.95	10.27	9.45	3.86	9.77	9.85	7.29	11.52	12.35	14.07	23.70	10.26	16.10	11.11	12.49	10.43	12.71	4.70	11.16	13.88	5.28
44	15.00	11.15	10.00	10.32	3.39	10.30	10.82	7.34	15.03	12.83	14.40	19.61	10.19	26.00	12.26	12.45	12.24	15.02	4.99	12.49	13.72	5.81
45	23.76	7.55	9.17	9.89	-	8.35	10.76	7.07	12.84	19.32	11.37	19.58	8.84	17.26	11.70	13.40	10.94	12.01	4.57	10.61	17.21	5.98
46	5.58	3.01	4.31	5.11	-	3.21	3.28	4.50	4.52	5.67	4.59	5.16	3.62	4.84	3.41	5.38	4.44	5.00	-	3.87	3.98	4.86

Table 4: t-*values between sequences 23–46 (except 37 & 41) from North Elmham Park –* t-*values less than 3.0*

	24	25	26	27	28	29	30	31	32	33	34	35	36	38	39	40	42	43	44	45	46
23	7.42	8.17	7.78	6.55	4.54	7.54	6.71	6.92	8.57	6.56	7.71	-	8.28	7.91	-	-	4.44	8.69	10.31	8.59	6.16
24		12.18	8.49	12.71	5.53	9.03	3.80	10.32	9.27	16.74	14.34	-	11.17	9.99	-	-	3.41	10.50	13.83	11.16	4.36
25			8.67	10.56	5.63	13.41	3.49	13.91	12.89	10.99	14.69	-	15.29	12.02	-	-	3.66	11.95	15.60	13.20	3.99
26				7.04	3.63	9.74	6.11	10.03	8.45	7.98	10.87	-	10.52	7.84	-	-	4.11	9.42	11.93	10.52	3.59
27					5.62	8.54	-	9.55	7.37	15.29	11.17	-	9.08	8.64	-	-	-	11.43	11.11	10.42	3.82
28						5.48	-	5.59	7.57	5.51	6.78	-	5.56	7.42	-	-	3.59	5.33	5.76	5.80	-
29							5.59	23.29	11.48	8.16	10.43	-	17.77	11.86	3.53	-	5.08	11.44	14.17	18.61	5.51
30								4.45	4.42	3.36	3.03	-	4.82	3.67	-	-	3.34	4.66	5.35	4.09	3.99
31									10.84	8.37	10.65	-	17.40	12.56	-	-	3.97	14.04	16.24	21.58	4.12
32										7.62	9.45	-	11.88	12.36	-	-	4.54	10.15	13.24	12.20	3.91
33											14.75	-	8.58	9.09	-	-	3.10	9.23	11.92	10.87	4.24
34												-	11.58	9.51	-	-	3.30	10.30	12.06	11.91	4.81
35													-	-	3.71	7.41	-	-	-	-	-
36														13.30	-	-	3.49	12.10	14.80	14.05	4.52
38															3.23	-	4.07	12.53	14.03	16.27	5.06
39																7.86	11.17	3.27	-	3.25	-
40																	4.40	-	-	-	-
42																		4.91	4.34	5.23	-
43																			16.80	14.86	5.10
44																				15.79	5.34
45																					4.56

Table 5: Example t*-values between the composite sequence from North Elmham Park and middle Saxon oak reference data*

	AD 572–785
London, Barking Abbey (Tyers 1988)	6.35
London, New Fresh Wharf boat (Tyers 1994)	5.97
London, Cheapside (Tyers 1992)	5.67
Suffolk, Greyfriars Road Ipswich well (Hillam 1989)	5.08
London, Barking Abbey Retail Park (Tyers 2021a, b)	4.82
Devon, Burlescombe (Tyers 2007a)	4.59
Kent, Ebbsfleet (Tyers 2007b)	4.33
Norfolk, Great Ryburgh (Tyers 2022)	4.28

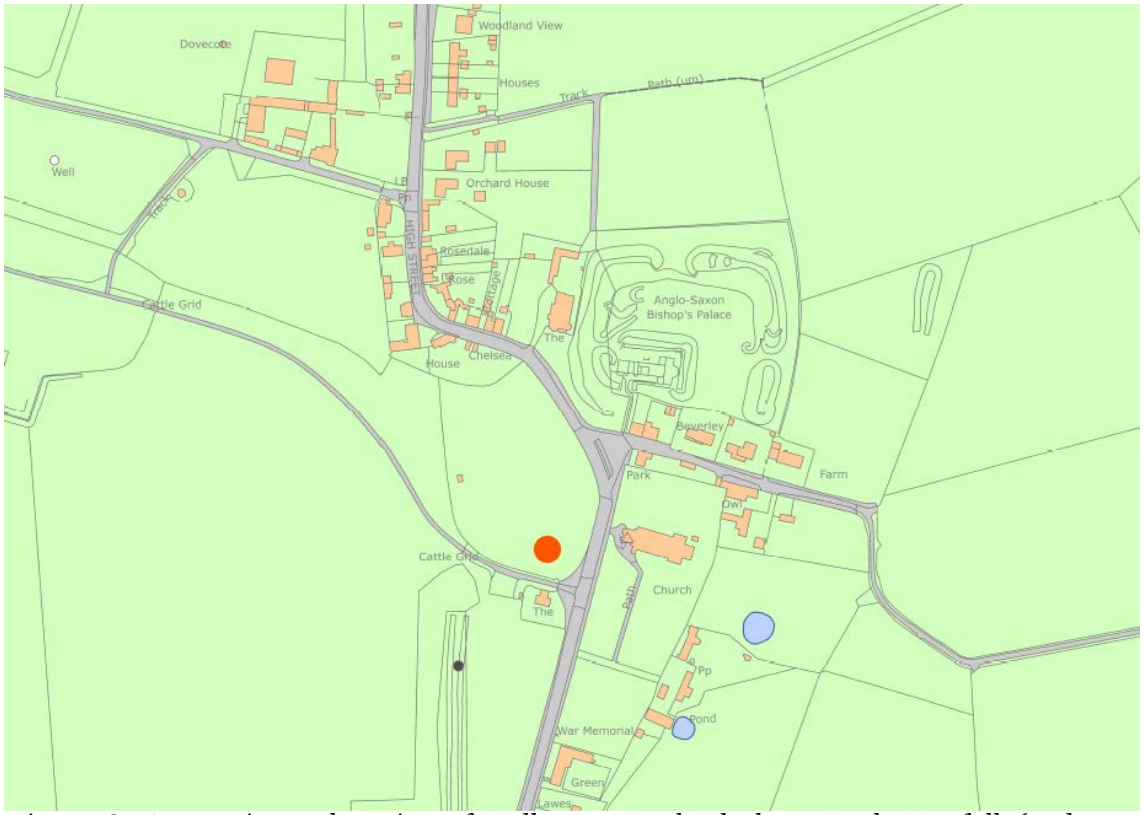


Figure 2: Approximate location of Well II at North Elmham Park, Norfolk (red dot). Scale: 1:3,300. © Crown Copyright and database right 2024. All rights reserved. Licence number 100024900

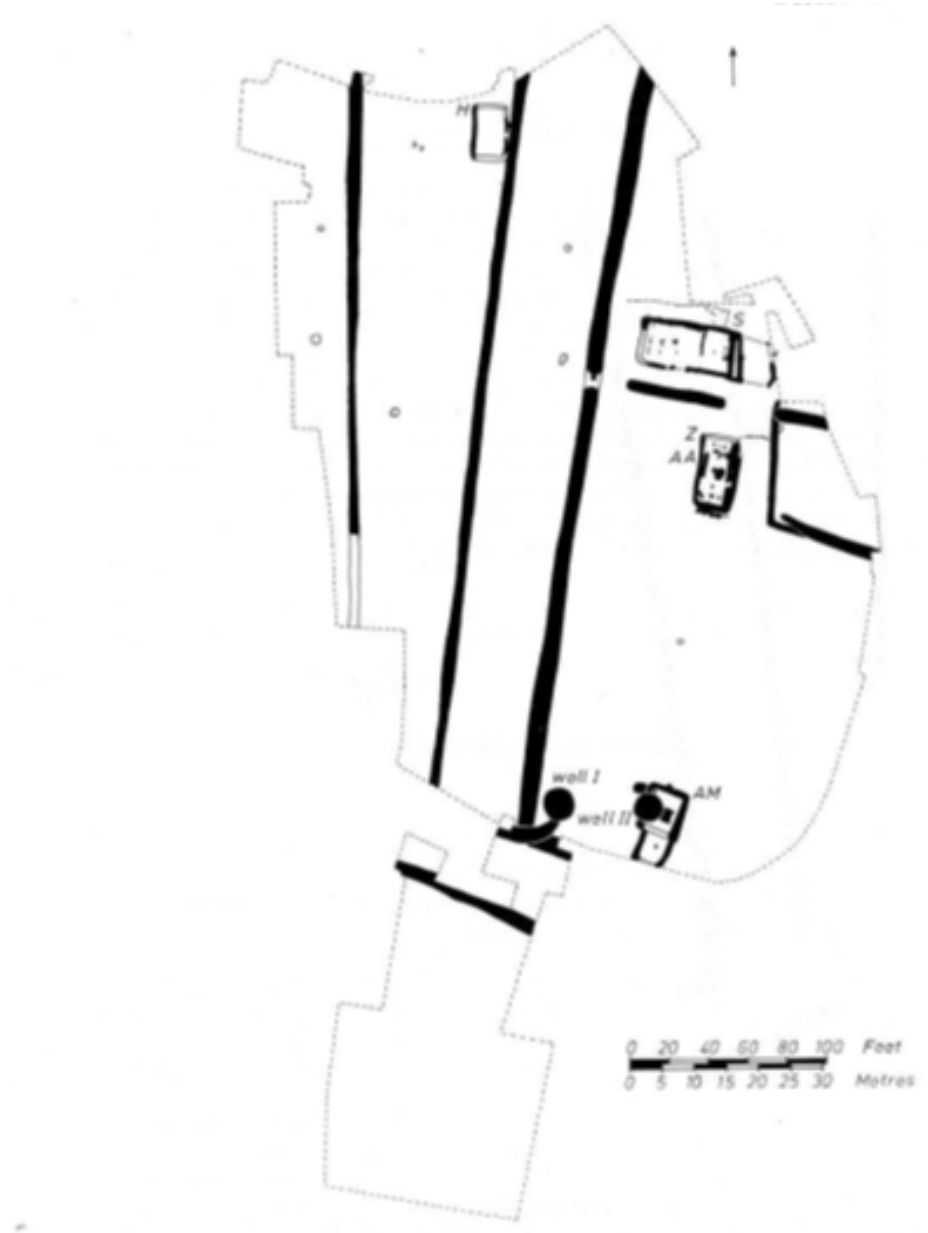


Figure 3: Middle Saxon features at North Elmham Park (© 1980 Norfolk Archaeological Unit, reproduced by *permission of East Anglian Archaeology (Wade-Martins 1980, fig 71))*

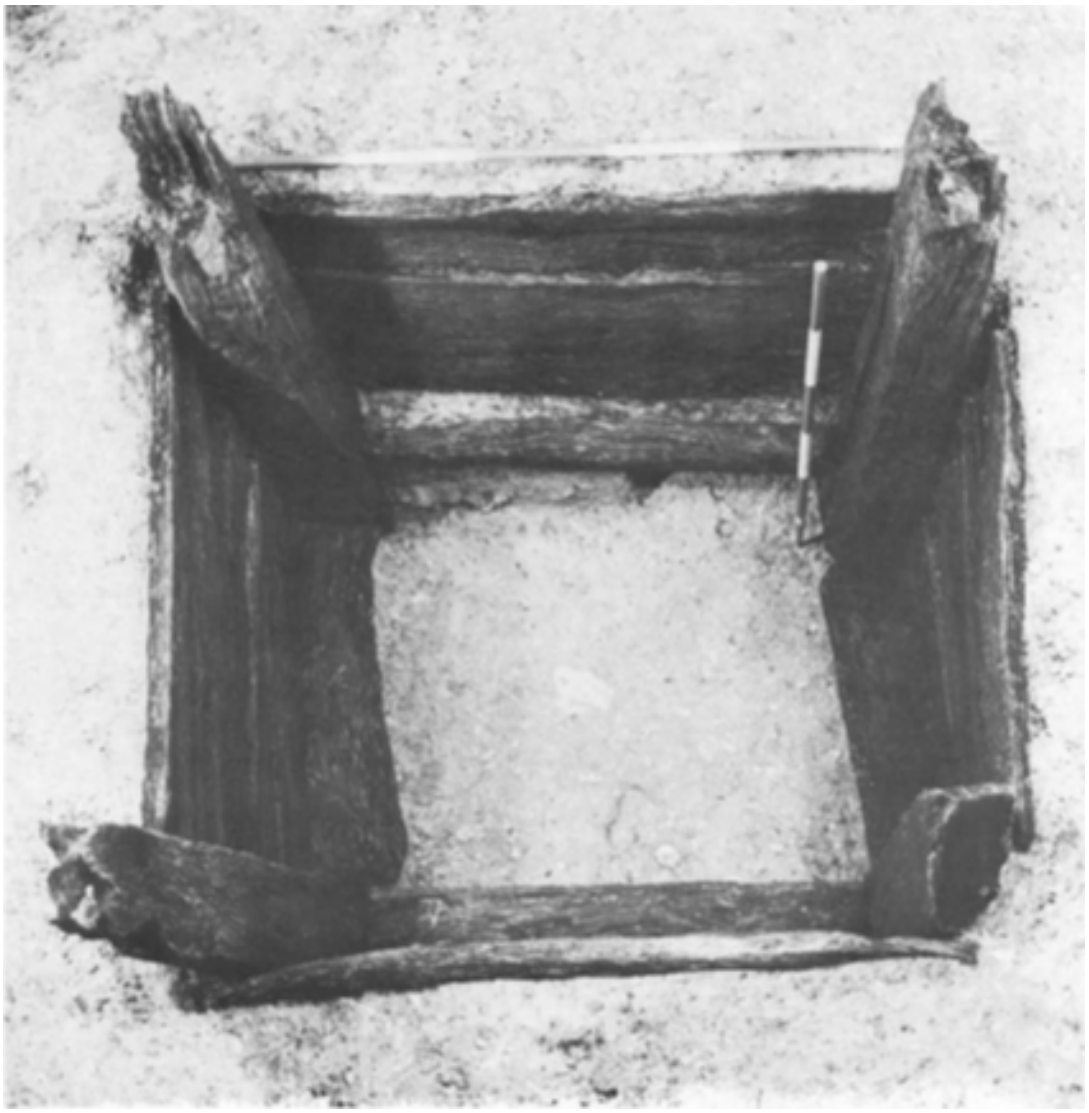


Figure 4: Well II: a general view of the bottom of the well from the south. The four lower bracing boards can be seen lodged between the corner posts around the bottom of the shaft (© 1980 Norfolk Archaeological Unit, photograph by Marius Cooke. Reproduced by permission of East Anglian Archaeology (Wade-Martins 1980, Plate XXXIX))

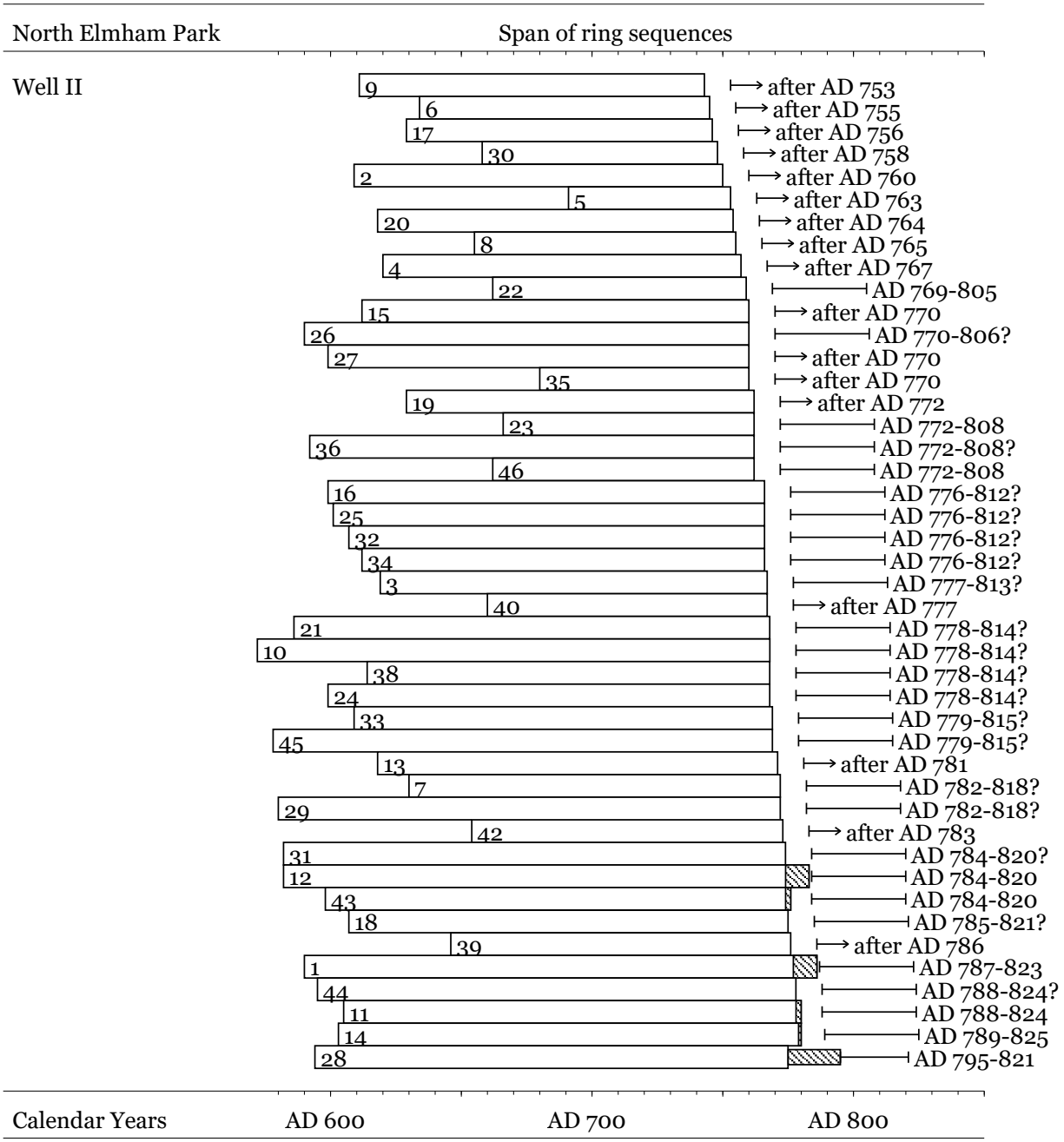


Figure 5: Bar diagram showing the absolute dating positions of the dated tree-ring sequences from North Elmham Park, Well II. The interpreted felling dates are also shown for these dated samples

KEY: White bars are English oak heartwood, the hatched sections are sapwood, the narrow, hatched section on sample 28 was detached.

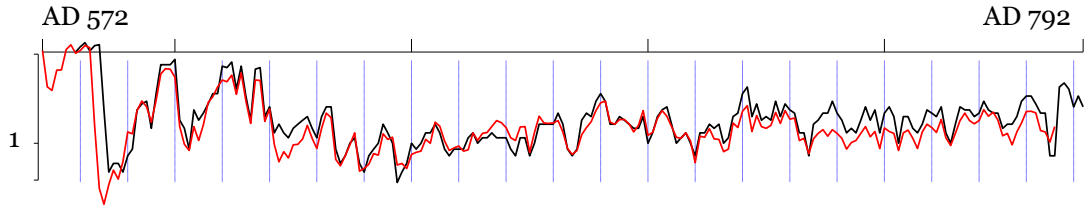


Figure 6: Bar diagram showing the composite tree-ring sequences from North Elmham Park, Well II. New data red line and 1972 data black line

HAPPISBURGH 1947–8

In 1947 two wells were exposed following coastal erosion on a cliff face at approximately TF 3679 3250 (NHER7085) in Happisburgh (Figs 1 and 7). In 1948 the timber-lined example was excavated and thirteenth-century pottery sherds were recovered.

Five timber samples numbered 47–51, from this site were suitable for dendrochronological analysis, although each of these had relatively few rings (Table ~~6~~). Samples 48 and 50 cross-matched, *t*-value 10.19, but none of the series were found to match reference data from Norfolk or elsewhere.

Table 6: Details of the oak samples from Happisburgh

Sample	Dimensions (mm)	Rings	Sapwood	AGR (mm)	Date of measured sequence	Interpreted result
HAP47	195 x 75	71	4	2.64	not dated	-
HAP48	150 x 50	65	-	2.39	not dated	-
HAP49	105 x 40	59	?H/S	1.68	not dated	-
HAP50		57	-	1.12	not dated	-
HAP51	90 x 35	63	12	1.43	not dated	-

KEY: ?H/S possible onset of sapwood; AGR = average growth rate per year

Figure 7: Map to show the location of Happisburgh, Norfolk. Scale: 1:3,300. © Crown Copyright and database right 2024. All rights reserved. Licence number 100024900

ST ANNE'S LANE, NORWICH

The Austin Friary in Norwich (NHER374; TG 2355 0827; Figs 1 and 8) was established around AD 1290 and received its first charter in AD 1293. The precinct extended from King Street to the west, bounded by the river to the east, St Vedast's Lane to the north, and St Anne's Lane to the south. A series of trial trenches, watching briefs, and excavations took place in this area between 1998 and 2008.

Two samples from this site, numbered 51 and 52 were suitable for dendrochronological analysis, although each of these had relatively few rings (Table 7). Neither of the series were found to match to reference data from Norfolk or elsewhere.

Table 7: Details of the oak samples from St Anne's Lane, Norwich

Sample	Dimensions (mm)	Rings	Sapwood	AGR (mm)	Date of measured sequence	Interpreted result
SAL51 114	240 x 120	64	15	3.19	not dated	-
SAL52 112	125 x 35	61	-	2.10	not dated	-

KEY: AGR = average growth rate per year

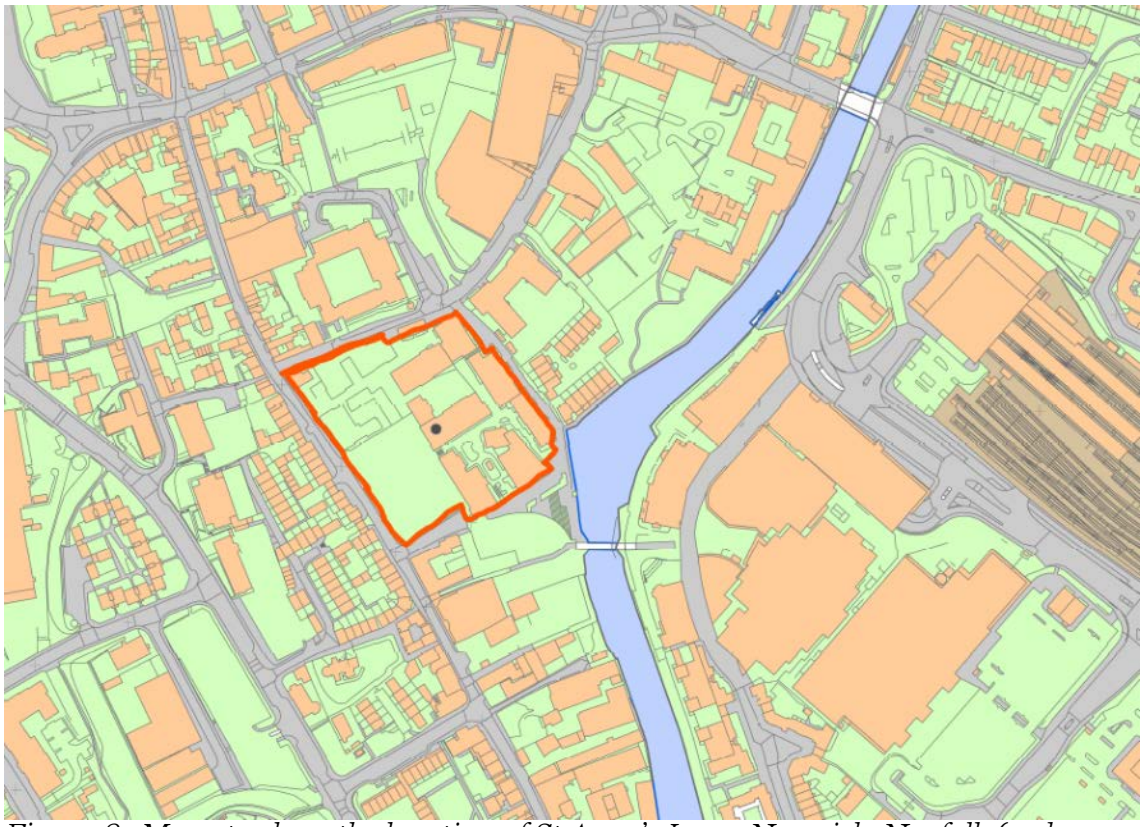


Figure 8: Maps to show the location of St Anne's Lane, Norwich, Norfolk (red outline). Scale: 1:3,300. © Crown Copyright and database right 2024. All rights reserved. Licence number 100024900

BRYANT'S QUAY, GREAT YARMOUTH

Archaeological observations during pipeline laying at approximately TG 5250 0680 (NHER 30081; Figs 1 and 9) between 1993 to 1995 recovered remains from boats reused as revetments.

Two samples from this site, numbers 16 and 19, both contained significant numbers of tree-rings (Table 8). Sample 19 was not found to match reference data from Norfolk or elsewhere. Sample 16, however, matched very strongly to data from Dublin and southeast Ireland, and to thirteenth-century oak boards identified dendrochronologically as being from the same area, but from English contexts, *see* Table 9.

An interpretation has been given to this board as a *terminus post quem* date based on the minimum estimate of 15 missing sapwood rings (Figure 10). This suggests that this board was felled after AD 1275.

Assuming this plank was one of the reused boat planks mentioned in the National Historic Environmental Record (NHER) summary, it is important to note that an Irish provenance of the plank does not indicate an Irish provenance for the boat from which it was derived. The thirteenth century is a period when England is importing planking from both Ireland and western Europe, probably due to the increased difficulty of obtaining high quality planking from native trees. There have been several groups of planks used in English thirteenth-century contexts previously identified by dendrochronology as of Irish origin. Salzman (1952), provides additional documentary evidence for the scale of this trade.

The long sequence length and slow growth rate of undated BG19 sample suggests it may also have been an imported timber, or a fragment form an exotic vessel. Possibly this was derived from somewhere for which we have relatively limited oak tree-ring data.

Table 8:Details of the oak samples from Bryant's Quay, Great Yarmouth

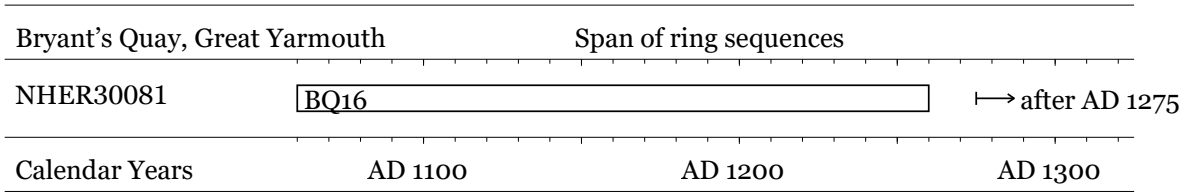
Sample	Dimensions (mm)	Rings	Sapwood	AGR (mm)	Date of measured sequence	Interpreted result
BQ16		201	-	1.03	AD 1060-1260	after AD 1275
BQ19		179	-	1.10	not dated	-

KEY: AGR = average growth rate per year

Table 9: Example t*-values between the sequence from BG16 from Bryant's Quay, Great Yarmouth and Irish oak reference data*

	BG16 AD 1060–1260
Irish site reference data	
Ireland, New Ross, Co Wexford (Brown pers comm)	7.01
Ireland, Abbey Street, Kilkenny, Co Kilkenny (Brown pers comm)	6.15
Ireland, St Patrick's Cathedral, Dublin (Brown pers comm)	6.10
Ireland, Kilkenny Courthouse, Co Kilkenny (Brown pers comm)	5.90
Other English examples of Irish timber	
Suffolk, Sizewell boat Irish (Tyers 2009)	9.05
London, Southwark Tooley St boat Irish (Tyers 1999)	8.60
Wiltshire, Salisbury Cathedral Triforium boards Irish (Miles 2002a)	6.12
Wiltshire, Salisbury Cathedral west front door (Miles 2002b)	5.95

Figure 9: Maps to show the location of pipeline at Bryant's Quay, Great Yarmouth, Norfolk (red line). Scale: 1:3,300. © Crown Copyright and database right 2024. All rights reserved. Licence number 100024900



KEY: White bar is Irish oak heartwood

Figure 10: Bar diagram showing the absolute dating position of the dated tree-ring sequence from timber BG16 at Bryant's Quay. The interpreted felling date is also shown for this timber

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APPENDIX 1

Data of Measured Samples. Measurements in 0.01mm units

North Elmham Park, prefix NEP

NEP01

53	57	98	156	196	165	252	594	716	663
577	150	108	88	197	123	158	226	325	249
384	328	310	204	373	192	161	401	395	138
155	83	41	71	60	80	99	117	180	155
102	149	154	135	42	57	80	102	114	65
69	64	82	69	141	105	94	62	63	62
108	112	116	108	103	151	148	79	61	87
94	119	133	167	163	129	129	140	137	125
126	117	110	113	110	83	123	166	154	186
154	168	144	87	89	98	167	183	204	223
259	202	130	160	144	141	124	98	130	180
86	106	130	170	140	118	80	82	115	79
73	97	113	153	113	115	73	106	142	115
167	266	146	207	205	147	163	191	148	186
161	167	91	104	62	98	114	163	148	152
139	118	76	103	108	149	162	130	138	81
124	126	137	120	152	169	105	107	129	180
140	125	165	119	114	149	187	165	181	175
176	186	178	148	155	100	121	124	151	116
177	191	154	113	122	102	134			

NEP02

230	267	236	264	291	259	183	118	182	169
84	48	33	45	43	39	64	57	56	83
69	94	120	237	216	110	61	74	80	78
54	46	50	83	72	92	97	135	67	49
53	72	59	82	93	101	128	137	95	45
76	85	60	62	99	97	168	155	149	163
225	161	105	95	166	163	113	140	95	115
108	111	126	94	72	63	53	83	78	74
127	107	152	109	108	132	134	113	110	129
246	106	135	155	154	113	133	128	129	115
143	89	161	74	115	111	99	78	56	150
127	175	161	110	168	120	142	131	198	154
200	152	140	112	96	73	112	115	103	101
109	80	100	112	109	128	108	109	92	123
111	101								

NEP03

210	259	118	82	104	91	109	88	99	113
81	69	86	119	181	91	81	108	135	136
63	62	67	77	72	110	93	73	51	52
55	59	82	43	93	119	153	141	160	170
139	140	106	88	109	98	121	124	242	271
247	159	138	198	149	161	106	164	223	144
150	153	192	148	119	78	65	97	125	170
201	275	236	159	167	198	165	160	138	155
210	95	96	159	220	206	130	93	88	137
106	78	126	141	185	118	139	89	124	168
140	198	266	151	172	153	140	146	176	152
218	209	173	103	123	84	134	165	175	141
156	157	146	121	120	130	149	164	155	152
97	146	119	138	99	137	124	111	85	128
139	128	125	200	114	101	190	212	188	

NEP04
193 99 52 83 74 70 74 78 89 77
69 88 157 173 50 43 53 56 94 51
65 64 63 57 62 58 75 48 56 69
53 79 54 82 80 76 92 72 74 56
80 76 73 128 98 117 120 115 125 78
95 92 118 135 125 78 148 261 178 166
173 183 140 97 116 93 142 131 140 204
212 211 122 149 167 167 101 110 114 194
102 165 186 177 130 116 104 95 103 96
63 133 120 113 89 101 86 124 151 148
194 217 125 180 153 124 128 156 155 178
160 191 134 151 76 85 131 137 134 133
119 124 93 106 85 101 93 94 88 76
89 97 89 97 102 114 99 74

NEP05
247 215 180 129 158 180 140 140 194 134
137 162 209 201 152 168 159 142 135 83
121 157 136 124 124 122 122 149 164 212
223 181 277 244 161 145 178 141 190 180
182 158 150 144 93 124 114 93 115 128
105 118 103 131 106 170 138 150 150 200
173 127 134

NEP06
103 98 131 140 158 72 63 96 130 100
140 117 108 65 64 66 100 87 75 131
131 172 163 117 91 121 114 88 91 109
103 107 103 112 148 128 105 92 70 104
115 75 91 121 130 118 93 101 87 59
64 61 88 120 147 185 230 234 151 169
133 144 126 109 129 143 80 87 140 205
165 110 77 71 162 105 85 129 137 154
124 138 120 90 161 153 212 270 141 200
179 170 167 169 177 178 143 147 77 82
93 90 89 81 70 82 77 65 65 60
51 47

NEP07
221 304 397 348 122 63 57 68 82 42
34 39 56 63 100 147 164 81 70 60
87 67 94 103 87 151 151 70 43 67
63 88 78 116 94 180 129 112 142 323
266 131 122 199 171 123 127 161 199 184
184 106 167 93 78 50 87 81 127 155
156 187 129 169 181 155 123 133 257 408
171 214 246 243 209 152 109 139 153 137
96 118 109 129 151 103 48 67 114 105
141 142 108 169 134 138 135 149 145 201
179 221 95 121 64 105 109 115 139 136
100 86 87 102 156 156 143 127 128 92
107 91 89 66 85 75 66 61 74 98
102 84 91 97 70 86 109 97 122 117
138 106 114

NEP08
158 162 191 184 137 139 106 82 109 90
100 122 212 233 234 156 142 158 162 150
114 131 154 127 173 145 170 128 82 92
92 156 166 187 158 189 169 117 112 103
122 133 103 131 193 92 109 144 231 170
130 106 114 151 126 75 135 126 153 88
138 90 144 196 149 236 287 145 243 140
151 150 149 156 186 226 172 114 104 82
154 171 171 137 153 139 127 102 111 145
148 164 137 129 68 129 140 160 95 121
149

NEP09

237	294	182	357	166	110	301	303	137	217
100	104	106	90	107	121	119	160	157	100
173	175	157	64	50	73	93	142	47	71
68	73	79	143	130	118	74	77	76	106
90	106	128	127	185	147	64	53	65	76
72	114	151	101	92	82	99	122	74	82
88	52	75	83	44	79	116	106	107	72
105	78	61	58	63	97	103	136	194	297
223	135	187	151	135	112	100	135	140	96
97	166	171	119	101	66	69	122	71	65
95	83	94	88	82	74	70	112	127	150
170	98	121	68	94	94	130	105	101	92
93	72	61	55	87	78	68	69	68	77
68	59	70							

NEP10

515	271	254	363	365	523	523	397	406	508
556	126	49	36	31	39	26	42	60	59
96	124	164	121	198	285	417	409	356	147
93	85	81	78	103	159	145	182	290	222
278	165	236	97	74	117	160	77	65	50
36	41	42	63	73	61	118	80	52	71
88	67	39	41	34	39	70	36	42	50
70	57	133	86	94	53	41	55	90	83
82	94	67	111	100	81	67	76	66	93
117	166	143	128	97	104	115	107	108	112
87	100	92	70	100	126	132	131	107	122
85	56	61	59	106	112	104	134	143	102
76	77	83	85	70	74	69	86	51	55
87	96	71	57	46	53	61	51	46	50
71	69	75	71	45	66	96	101	116	151
104	131	102	127	126	147	123	134	150	120
62	76	61	86	96	106	82	85	76	64
71	80	98	95	108	106	92	62	83	90
103	93	112	119	73	72	97	128	107	105
110	87	75	102	122	101	100			

NEP11

154	240	306	271	355	449	369	391	315	452
338	211	321	366	194	208	391	313	201	178
229	249	233	268	193	114	227	357	232	105
55	64	93	119	74	63	65	74	68	105
107	93	55	49	50	72	75	93	110	66
100	105	68	45	55	56	66	52	76	59
84	75	72	85	101	91	76	72	133	135
93	114	184	151	143	111	125	88	74	62
78	135	149	135	183	261	201	111	135	162
149	148	134	129	173	101	127	188	154	177
151	114	123	122	111	88	139	120	140	108
126	91	65	161	168	253	231	154	176	118
145	135	191	177	207	181	155	126	124	84
142	152	168	158	151	136	133	123	110	125
152	150	125	175	112	152	168	160	89	186
151	144	105	134	168	179	174	188	140	79
127	189	179	166	151	175	265	279	214	180
159	125	114	146	159	171				

NEP12

379	140	42	26	40	60	63	102	122	136
210	213	211	131	177	309	287	311	326	131
83	89	137	107	165	190	204	243	314	313
369	196	348	218	88	275	273	154	149	77
65	76	85	112	99	139	142	118	103	136
144	122	59	37	43	81	116	63	73	72
96	100	130	140	155	63	60	48	89	99
102	102	98	133	109	69	58	65	60	53
43	68	45	60	53	66	54	60	51	48
37	71	86	56	110	243	154	131	128	142
165	76	76	94	125	190	195	210	246	194
117	119	162	136	121	112	107	138	89	102
163	190	154	124	98	85	112	94	64	120
105	116	93	83	66	68	127	126	201	220
103	115	90	101	110	140	91	129	111	98
80	65	63	118	140	168	146	176	124	110
73	124	127	159	151	144	152	102	164	150
135	71	170	174	134	101	132	213	162	147
163	123	110	130	189	205	179	137	150	258
187	198	160	111	84	69	124	122	169	161
188	137								

NEP13

376	161	159	87	81	82	54	76	60	52
103	53	54	87	128	151	50	40	64	93
96	40	67	54	66	75	94	95	79	40
38	38	52	51	45	72	57	110	121	64
47	49	60	50	35	70	78	69	76	115
189	190	212	167	228	238	225	109	203	185
219	186	173	206	118	50	80	54	122	157
195	165	214	135	139	60	104	121	147	97
111	205	96	104	178	107	210	139	102	105
128	75	43	170	92	96	73	80	26	58
150	139	120	164	65	118	151	119	190	237
126	193	118	143	110	81	79	98	187	228
141	153	206	192	145	156	115	178	261	132
181	87	204	225	364	156	241	296	251	156
213	217	214	246	403	132	135	195	218	222
170	153	206	150						

NEP14

94	146	75	108	163	187	393	366	371	434
228	296	174	106	246	290	95	133	49	57
68	66	97	94	106	133	92	89	129	144
155	55	44	61	77	105	47	48	60	71
81	108	105	86	51	52	52	73	83	91
113	100	147	145	83	49	79	76	82	68
120	83	95	82	121	126	119	119	96	82
141	134	62	102	165	129	123	110	114	85
80	68	89	125	160	128	175	244	184	91
93	125	124	138	127	104	140	69	95	136
129	152	108	88	103	104	90	71	125	100
124	122	132	87	64	160	156	230	248	140
166	121	143	154	197	145	170	158	180	120
107	74	140	151	187	177	183	147	145	126
151	143	179	186	161	168	100	188	170	148
87	194	144	132	115	150	174	151	130	144
120	108	124	156	190	160	131	131	194	149
144	167	129	106	96	89	175	184		

NEP15

489	285	597	234	158	420	459	149	203	100
87	109	78	99	89	88	142	119	86	113
106	122	81	85	106	135	157	59	70	88
96	92	107	100	97	53	58	58	84	65
66	98	108	129	122	96	80	87	86	66
62	94	78	80	74	96	118	125	108	101
64	99	107	55	96	111	116	104	77	118
83	78	65	69	88	110	150	157	207	202
119	145	142	126	106	125	130	102	64	83
138	212	169	109	75	70	148	113	63	136
132	172	133	139	117	87	157	130	160	284
131	198	168	133	146	165	150	151	125	139
93	104	86	123	110	123	88	111	105	108
78	86	73	97	115	98	69	65	90	85
92	57	71	84	73	65	97	163	149	

NEP16

365	363	215	167	119	219	117	147	213	288
238	339	348	425	249	440	195	136	351	274
156	225	122	100	107	110	103	108	118	152
149	113	183	129	120	78	67	72	93	130
80	86	78	98	100	156	100	98	66	85
64	105	94	101	120	118	177	144	89	71
66	80	78	106	141	98	99	96	105	105
103	137	114	90	98	110	76	108	171	123
132	100	119	71	66	61	64	87	120	155
188	272	177	132	130	121	116	124	121	132
120	93	93	133	199	167	104	85	74	132
109	72	100	123	125	112	130	103	85	138
122	175	203	107	143	107	115	128	148	102
145	114	114	74	64	62	81	94	85	79
78	83	69	55	67	65	66	69	62	66
48	63	53	60	54	65	47	65	50	76
111	89	80	94	78	76	96	137		

NEP17

141	100	144	158	142	63	71	87	103	151
70	87	92	90	94	151	112	115	66	74
77	92	102	94	117	101	157	131	103	70
85	75	75	88	129	96	95	84	89	85
78	96	84	61	96	100	67	87	115	109
107	93	97	53	63	52	60	80	82	104
140	176	174	118	160	134	124	104	104	126
128	91	90	158	209	174	122	92	106	135
104	81	123	139	163	108	121	97	69	147
133	178	232	122	158	125	126	152	152	125
160	135	130	83	74	67	83	87	92	71
89	73	54	50	62	70	84	110		

NEP18

249	335	466	479	423	435	417	502	292	107
199	351	144	175	82	53	66	57	94	77
87	141	131	79	121	163	150	59	52	50
65	87	43	49	61	85	70	113	105	111
59	50	103	93	86	90	90	87	139	127
67	43	47	57	61	62	77	47	80	68
64	72	86	72	65	68	136	139	100	111
134	142	142	97	106	79	55	70	72	111
147	163	186	248	233	127	114	127	120	116
135	182	243	98	118	176	216	147	128	95
116	129	97	70	94	114	112	89	99	86
65	121	136	172	140	134	150	125	130	156
185	125	226	184	171	78	92	70	100	135
119	117	156	126	116	122	138	133	154	150
115	197	104	141	152	157	82	157	156	87
82	141	173	206	159	185	109	101	150	187
254	223	173	163	149	159	150	114	82	

NEP19

80	59	67	67	94	101	121	147	166	164
68	67	102	104	114	128	92	58	50	70
65	71	74	47	82	103	110	102	157	159
143	130	109	84	102	74	62	74	135	145
170	115	78	122	140	135	80	122	168	142
107	101	130	105	74	74	71	90	92	105
123	147	156	115	111	121	116	123	84	101
143	110	96	123	127	136	107	84	87	90
103	71	107	123	128	96	112	85	144	122
150	160	158	106	143	125	95	122	108	99
124	138	140	114	139	84	109	126	112	108
143	137	134	116	106	105	122	126	98	115
112	110	139	120	104	128	137	101	93	138
128	93	129	150						

NEP20

280	145	166	82	67	83	73	101	105	135
128	87	85	126	117	133	73	60	55	77
88	71	67	80	86	100	142	138	124	66
96	68	102	96	116	209	135	195	168	97
70	76	83	81	84	114	76	86	69	89
103	62	82	59	43	58	67	54	63	85
104	96	78	117	92	64	57	57	89	105
126	116	189	179	109	97	122	123	122	117
119	128	92	103	117	155	157	94	77	70
111	70	51	87	84	84	87	98	80	95
139	102	205	207	112	130	70	103	94	122
119	123	111	128	95	85	64	111	105	116
80	101	85	72	65	93	71	106	106	90
105	75	111	109	102	79	86			

NEP21

63	74	59	85	96	71	125	175	137	88
197	332	309	387	286	94	86	67	125	89
137	247	240	227	215	261	317	204	301	202
116	212	238	141	146	70	52	67	62	86
95	109	134	111	84	105	193	131	86	76
81	113	126	45	62	72	79	76	98	99
111	63	57	60	74	84	77	86	78	85
87	94	79	70	78	80	69	108	93	103
102	127	142	94	109	83	71	154	129	62
118	220	155	152	131	134	112	63	68	62
78	65	102	116	152	180	98	103	122	147
113	103	98	139	88	122	156	135	129	106
77	79	113	95	65	87	82	108	98	92
66	86	145	142	206	215	108	162	96	122
118	181	148	157	166	159	113	127	71	128
131	129	131	125	106	68	81	81	97	97
110	93	95	93	101	93	99	72	94	91
98	69	80	99	100	104	93	74	69	89
111	96	83							

NEP22

214	269	294	300	239	169	177	78	58	72
86	126	146	65	62	63	49	39	38	44
41	31	33	33	39	64	83	100	100	183
131	131	165	142	96	80	140	101	60	76
82	95	77	59	56	49	70	31	30	58
40	47	60	48	37	38	46	77	79	69
64	88	95	94	116	116	106	88	62	68
54	65	45	67	75	88	81	80	91	67
47	62	64	64	62	55	79	53	73	55
56	41	66	44	43	33	39	38		

NEP23

310	238	249	181	165	129	118	169	237	121
122	148	156	169	143	129	84	71	72	72
79	103	93	169	141	235	97	86	117	104
101	70	104	126	76	83	107	180	152	126
118	107	124	70	55	81	86	72	52	61
38	39	101	141	130	131	106	184	134	128
141	194	176	241	179	138	86	100	62	90
115	131	122	134	95	79	74	81	99	99
115	98	103	70	96	86	61	44	56	60
50	41	69	102	82	61	59			

NEP24

252	260	180	129	112	112	73	82	143	136
311	405	277	356	225	361	210	75	247	364
191	240	112	104	120	121	114	92	95	147
94	76	105	124	131	94	96	112	140	149
68	95	104	118	134	133	138	139	98	82
91	103	111	90	121	96	166	157	123	101
94	111	126	99	168	103	107	139	133	135
157	118	140	131	163	151	95	131	170	187
170	137	189	98	67	77	83	140	186	183
189	207	159	139	129	108	118	118	98	100
153	82	113	129	169	153	129	88	99	103
84	58	106	91	106	84	90	67	95	151
134	179	199	138	160	130	127	115	183	133
158	131	120	104	95	68	101	131	137	119
123	99	97	83	95	92	111	140	134	140
71	119	135	144	88	125	142	99	95	144
142	144	121	166	137	117	155	183	198	128

NEP25

129	120	119	214	156	195	194	252	301	336
322	333	287	366	281	233	471	300	182	239
76	69	83	87	115	105	113	141	124	72
100	174	237	85	87	98	143	179	99	76
100	110	105	172	152	135	73	71	68	97
96	87	135	118	213	180	94	74	114	110
92	93	140	112	109	100	142	164	161	129
123	105	125	131	93	129	152	153	136	112
132	84	64	59	57	109	127	155	150	199
168	129	177	133	170	137	128	117	172	93
100	143	175	158	116	79	101	110	75	66
99	114	134	105	96	99	77	162	134	193
211	135	181	140	131	124	154	143	194	158
158	118	81	48	63	102	94	85	118	77
73	52	72	78	84	128	84	82	68	107
99	87	54	83	114	73	56	115	106	103
66	85	47	59	74	63				

NEP26

411 369 437 449 375 309 302 296 313 321
235 123 79 65 53 70 84 135 139 287
301 339 301 239 236 149 109 309 233 70
72 63 37 38 36 60 47 50 70 49
58 93 182 169 80 76 90 67 80 71
52 52 63 67 72 60 78 59 73 56
71 70 79 83 85 90 85 57 46 62
40 40 35 59 43 62 47 65 72 87
79 56 58 81 102 60 77 92 81 70
64 67 53 47 38 40 51 43 47 79
104 121 87 83 64 92 71 81 90 127
80 90 78 83 82 59 49 47 50 49
42 55 48 46 45 53 36 32 62 63
82 79 58 56 40 48 47 72 62 68
52 54 42 34 29 43 52 61 66 59
47 46 36 39 40 47 40 46 50 45
47 49 53 42 63 55 56 53 66 83
64

NEP27

281 248 91 64 54 53 46 76 98 82
114 100 186 174 112 234 153 76 194 254
158 195 120 91 116 93 98 120 107 134
107 77 86 88 127 93 103 121 137 144
59 66 72 70 95 123 118 124 64 75
63 81 90 64 99 147 181 174 188 201
184 176 130 130 137 114 174 147 215 191
236 160 107 146 122 129 95 141 220 142
138 98 173 119 85 81 64 99 140 184
185 276 209 129 157 144 137 115 90 135
209 117 119 185 200 205 155 122 89 129
110 75 136 158 175 130 120 101 117 132
141 180 189 101 131 99 116 116 149 144
153 166 152 86 105 66 123 143 132 117
141 131 113 121 122 137 173 191 160 157
81 121 131 127 81 113 153 94 70 121
142 129

NEP28

179 195 169 175 166 308 59 47 82 67
81 94 111 213 265 104 55 88 162 177
174 138 83 245 244 154 187 81 55 105
87 100 109 107 162 151 133 181 177 52
51 57 77 76 144 53 71 67 83 71
129 105 140 67 63 82 68 67 117 104
106 155 152 98 59 81 89 111 91 158
89 180 288 250 224 233 246 188 85 59
79 77 67 123 122 141 118 136 91 126
92 69 90 109 150 170 138 182 142 126
145 126 118 84 71 112 87 105 293 235
256 268 138 76 94 109 75 92 88 128
101 121 80 112 142 152 154 165 138 143
92 118 121 159 158 161 129 141 100 93
78 80 73 112 88 120 90 48 39 50
65 55 70 72 79 59 89 74 85 61
81 102 77 58 81 82 85 62 75 60
63 76 87 100 98 98 122 126 110 84
74 67

NEP29

512 565 520 120 41 40 53 81 71 83
90 104 199 206 146 84 197 326 234 274
251 118 91 86 139 101 120 175 251 275
260 284 328 257 410 266 250 307 313 137
200 90 46 76 63 106 103 132 136 110
77 116 202 152 46 46 63 79 119 47
48 58 79 62 106 100 112 67 80 80
88 106 109 94 78 100 94 66 55 69
52 54 54 98 91 76 99 139 190 138
134 131 129 116 115 49 111 147 101 106
96 106 85 64 61 50 82 63 85 141
171 233 148 124 152 145 120 95 95 133
93 114 152 143 133 111 92 89 86 67
62 94 74 87 73 88 65 75 129 116
172 167 102 131 102 102 102 130 98 139
138 126 92 104 52 99 99 111 104 97
96 77 75 78 91 98 98 86 97 85
96 92 85 77 85 80 85 58 87 87
87 76 72 53 62 68 99 82 81 95
99 102 79

NEP30

355 232 144 99 80 117 252 239 157 129
139 110 102 102 172 221 188 95 112 105
86 109 83 87 66 56 60 62 86 102
81 175 177 215 90 65 89 78 61 67
69 75 56 65 71 99 81 82 44 57
45 22 29 45 26 34 23 44 19 22
60 41 50 35 35 30 28 28 30 58
38 46 49 58 44 33 31 22 28 33
29 29 21 26 23 26 21 36 34 39
64

NEP31

540 136 46 38 54 72 67 70 80 88
161 214 125 101 155 318 305 308 360 137
98 95 208 155 207 263 258 256 307 313
308 265 395 235 156 294 286 172 153 85
51 66 67 74 82 101 123 110 91 146
277 158 54 49 83 94 135 82 67 68
84 79 142 131 133 78 74 73 84 99
95 122 104 145 119 68 41 62 65 80
92 133 138 124 122 146 160 118 140 130
90 126 95 58 125 170 123 118 137 162
132 89 86 84 106 105 111 156 228 243
154 169 186 162 159 121 108 182 95 152
184 156 140 139 108 104 118 86 67 107
87 99 87 92 81 80 153 122 198 216
129 163 122 143 110 162 145 211 173 157
100 118 71 102 107 134 115 113 102 88
86 92 93 81 109 101 97 80 83 91
85 73 89 100 74 55 75 81 73 75
62 58 50 58 44 59 58 48 72 112
89 97 81

NEP32

341	282	443	432	393	412	375	391	251	295
302	300	166	267	78	48	79	59	81	101
106	150	107	93	118	173	128	64	57	74
68	87	56	67	62	76	68	99	82	101
47	41	49	73	52	95	85	79	87	73
35	30	41	43	52	38	58	53	78	71
92	110	151	106	85	71	122	122	58	73
136	127	113	90	94	63	42	40	35	59
57	88	108	117	144	116	112	120	107	115
93	105	122	82	95	119	170	128	87	54
69	89	82	62	83	69	98	81	77	51
53	101	79	104	123	107	128	94	92	92
126	135	137	131	144	77	69	53	100	95
107	117	117	97	66	55	72	79	81	92
101	100	50	87	72	66	50	69	76	67
54	70	105	99	78	75	56	64	83	48

NEP33

253	160	256	289	168	305	185	102	377	377
132	249	119	93	117	108	122	122	105	105
94	84	105	116	176	117	129	134	144	142
71	69	76	89	87	118	108	75	75	67
89	82	87	52	80	93	123	122	135	153
118	122	102	96	102	112	159	205	189	216
176	126	129	120	152	137	91	107	135	150
132	117	173	91	82	61	96	127	164	146
147	161	147	119	117	109	122	117	106	111
137	88	101	128	151	146	126	85	93	101
84	59	89	94	108	96	96	73	111	168
143	235	297	156	210	169	157	141	143	157
225	188	164	111	101	81	129	159	166	155
155	128	125	115	103	122	140	166	148	141
66	135	135	150	87	118	152	109	89	121
105	117	111	127	97	97	136	189	165	151
159									

NEP34

326	230	365	211	125	473	322	122	237	115
82	101	83	105	110	121	147	126	102	141
184	199	103	115	119	138	125	74	72	66
76	87	122	97	128	115	124	86	96	90
84	122	104	164	120	116	103	88	91	81
75	113	85	90	112	130	148	167	156	140
119	128	132	79	109	152	135	151	126	162
97	89	68	67	108	148	162	171	199	179
148	155	134	138	156	131	115	132	79	98
137	170	180	118	80	115	125	86	81	126
118	139	94	89	100	63	132	114	175	188
116	150	113	133	129	150	114	169	127	122
96	84	45	91	99	141	131	140	112	97
75	74	98	84	124	100	80	64	89	86
80	59	72	85	70	48	65	97	102	78
142	103	94	122	129					

NEP35
603 420 454 384 330 421 416 391 342 506
370 573 452 340 348 408 494 375 499 567
466 316 266 416 401 406 521 431 258 267
161 230 351 429 298 271 370 289 330 277
257 352 344 492 473 409 335 529 431 565
393 492 377 427 328 247 225 329 266 389
380 445 245 341 281 350 320 252 302 323
346 304 296 346 238 261 287 292 340 251
289

NEP36
138 178 181 122 191 269 243 203 157 101
62 49 88 89 94 116 123 206 181 187
207 175 221 147 120 239 210 93 109 66
36 52 37 63 64 95 107 87 65 83
153 135 39 38 47 66 98 35 45 55
67 56 85 68 72 39 53 52 57 59
68 68 32 65 65 33 21 26 39 37
47 67 50 65 59 70 79 85 88 76
80 83 82 43 80 116 76 83 89 95
77 49 61 44 63 69 82 119 162 189
119 123 110 107 89 85 84 125 72 90
114 110 90 74 65 65 68 61 44 74
63 86 47 62 50 51 95 89 131 126
88 114 99 83 79 127 123 132 120 111
74 63 54 74 111 109 94 97 67 59
59 56 71 75 88 80 68 58 81 94
74 55 53 73 63 53 64 71 81 62
74

NEP38
318 304 272 504 468 300 358 170 59 100
101 107 106 127 143 134 132 198 233 228
119 96 112 134 161 96 77 54 81 57
90 82 105 72 68 53 84 73 88 96
87 142 167 118 59 87 95 115 125 162
153 160 192 178 187 191 211 156 130 189
149 126 188 242 218 223 173 200 162 117
117 127 161 144 169 182 211 234 144 154
185 157 131 145 137 153 109 132 162 181
133 125 90 80 139 112 74 120 109 108
99 100 64 74 122 125 184 197 135 191
143 137 145 174 216 194 200 200 100 119
73 131 161 120 104 112 98 92 66 75
93 114 148 119 104 83 119 114 103 74
92 122 106 95 115 122 118 121 120 88
71 100 155 135 158

NEP39
206 194 243 67 61 110 149 194 147 230
195 268 169 211 180 71 39 80 83 110
134 242 334 301 303 263 237 311 319 176
287 266 234 199 260 219 204 212 147 236
184 203 232 252 219 338 203 141 199 213
229 148 138 187 212 177 174 176 207 184
184 168 151 159 76 125 165 212 221 160
132 169 185 136 189 258 204 219 213 197
275 234 163 245 165 262 157 189 232 152
128 89 85 108 271 253 201 230 191 220
273 153 144 126 265 157 150 89 140 160
232 198 276 276 207 273 430 274 207 152
172 259 214 239 176 231 208 264 217 136
174

NEP40

272	253	146	148	138	130	193	203	209	295
229	150	203	194	187	221	221	239	214	225
361	276	327	260	201	256	266	227	270	374
347	419	448	388	386	367	315	281	319	389
375	298	243	301	305	339	394	345	194	262
126	154	253	247	215	157	180	175	215	161
192	176	155	221	243	182	181	200	139	242
183	237	168	221	178	151	126	84	87	96
197	159	111	130	137	172	174	100	173	144
196	118	117	113	157	162	189	215	248	224
151	213	362	228	185	155	193	249		

NEP42

168	302	282	310	168	199	180	84	52	88
85	92	100	128	202	152	200	167	127	197
279	156	282	307	307	313	301	296	295	258
210	225	205	241	268	338	289	483	371	217
383	374	377	289	329	358	358	265	273	253
247	300	238	274	234	330	147	233	169	217
259	201	171	185	269	183	205	219	155	164
183	177	250	367	195	304	233	270	225	253
226	183	116	141	152	189	211	178	113	115
116	127	123	115	143	131	243	216	98	101
176	167	155	140	152	149	153	143	193	113
109	102	112	221	116	158	148	138	162	185

NEP43

491	476	440	160	106	131	164	151	190	254
289	243	430	457	528	296	475	302	158	346
327	198	184	104	81	73	82	114	112	151
174	114	106	157	222	193	89	47	61	84
125	85	89	98	117	103	147	150	161	85
73	61	79	100	84	110	126	163	156	94
56	66	71	67	68	73	54	56	47	59
71	69	76	42	42	51	73	55	100	255
211	276	331	278	298	127	81	105	152	238
242	249	329	257	162	148	224	193	147	130
119	176	120	151	214	237	202	127	120	103
152	126	75	163	118	148	105	114	84	76
201	192	297	210	106	145	128	134	129	223
144	156	157	134	60	59	73	97	141	175
150	205	150	136	91	139	108	157	167	140
177	126	198	186	155	103	215	202	180	113
140	282	258	193	195	129	99	157	269	229
239	180	188	290	210	259	207	139	109	

NEP44

136	256	331	298	311	303	165	113	108	113
109	123	206	198	317	266	271	295	208	287
218	115	278	265	108	142	54	56	86	75
114	116	148	143	96	90	115	161	146	56
46	52	61	96	54	55	50	81	75	115
123	106	56	48	48	70	92	82	96	93
132	115	53	44	60	70	75	69	89	78
84	75	81	98	94	75	71	72	116	122
78	78	118	112	101	87	100	64	52	56
72	102	119	104	156	195	153	91	100	115
126	125	130	113	155	80	99	139	151	140
128	96	85	107	89	65	113	103	135	123
123	78	76	149	159	220	208	110	156	109
126	120	183	146	216	166	184	114	121	73
162	169	156	141	158	136	132	122	136	120
165	166	141	148	109	183	167	123	119	193
164	139	118	137	173	157	133	130	119	95
121	164	188	175	135	154	235	175	167	152
106	117	86	101						

NEP45

616 584 629 621 697 160 48 34 47 46
33 52 68 65 139 187 186 145 252 509
702 666 606 170 102 78 155 107 156 213
275 257 374 327 301 186 298 171 152 342
292 120 160 78 43 69 67 73 81 106
146 123 81 120 131 122 53 59 66 85
108 64 61 61 72 74 107 127 102 58
55 51 99 134 128 116 103 142 137 105
53 88 93 139 134 183 162 169 141 153
155 132 133 118 78 123 103 76 120 192
149 168 153 165 134 81 72 81 108 142
160 178 188 208 123 116 123 114 104 91
106 128 82 93 100 124 113 96 77 78
82 74 61 82 96 103 111 102 68 73
112 120 168 190 108 138 109 112 158 166
162 143 139 134 83 110 70 119 130 142
151 131 97 92 96 113 117 116 137 141
133 92 122 121 124 93 135 125 116 108
126 134 128 114 148 115 102 115 165 172
193 115

NEP46

296 225 223 277 223 150 68 42 60 81
91 49 42 21 27 34 46 67 47 44
35 25 21 24 28 30 25 47 48 63
56 70 121 211 108 108 110 162 97 86
123 184 73 78 51 70 85 54 57 68
62 49 46 59 41 41 69 86 123 88
60 62 64 60 100 108 87 129 100 99
67 60 33 68 57 64 42 42 59 50
38 37 50 54 50 59 62 40 67 51
48 36 44 36 36 28 37 69 65 56
59

Happisburgh, prefix HAP

HAP47

322 328 183 165 148 209 419 366 297 257
317 396 322 242 252 341 419 504 585 290
390 291 398 198 299 302 293 394 278 206
228 214 219 262 246 234 280 564 423 375
270 246 199 168 155 279 230 192 237 180
233 226 241 272 324 330 261 225 116 106
119 183 178 174 245 228 172 145 156 118
107

HAP48

177 204 273 197 275 237 215 115 180 292
342 201 204 199 151 124 125 154 208 124
255 327 247 201 319 193 252 231 304 421
344 211 335 298 389 365 338 372 428 224
332 299 209 190 269 495 250 170 233 297
388 156 230 223 279 119 159 140 154 135
119 226 218 107 115

HAP49

244 225 220 261 240 261 222 213 209 191
260 191 181 225 285 212 157 154 189 150
200 252 194 176 170 194 91 95 192 229
204 136 157 151 166 199 154 134 124 133
169 125 98 119 119 92 97 102 107 157
139 119 124 108 105 132 107 104 130

HAP50

109	121	134	102	89	59	71	75	82	92
138	131	52	172	220	119	99	149	99	97
85	107	189	108	73	73	79	103	93	122
146	175	85	125	130	67	89	111	140	117
74	118	166	165	97	106	137	113	92	106
106	110	101	76	143	135	116			

HAP51

373	123	189	212	138	102	70	70	90	84
156	193	135	128	122	142	140	123	119	109
100	152	121	189	151	167	131	74	123	129
166	242	129	149	107	137	160	139	158	86
153	144	206	109	160	222	129	189	191	70
102	118	128	192	114	122	114	88	129	220
165	152	144							

St Anne's Lane, Norwich, prefix SAL

SAL51

182	208	218	249	212	219	331	313	321	406
306	454	332	264	299	409	435	342	310	259
201	299	379	415	306	220	364	395	371	482
612	551	551	454	409	305	300	406	261	423
438	346	402	354	242	357	342	312	333	296
183	177	109	126	206	261	248	217	246	300
290	290	277	280						

SAL52

226	259	284	232	177	223	246	273	388	310
273	321	199	268	207	238	290	229	249	224
284	337	346	302	282	281	171	108	125	147
191	304	276	334	284	175	161	210	156	132
111	131	163	135	89	99	137	179	195	181
175	185	184	156	151	125	140	151	129	150
142									

Bryant's Quay, Great Yarmouth, prefix BQ

BQ16

126	155	114	93	70	84	96	108	95	70
98	52	73	75	93	125	110	96	92	102
96	91	98	110	92	110	135	144	111	132
68	47	37	81	87	106	86	114	135	132
106	104	84	117	76	123	131	107	148	128
96	130	119	101	120	131	142	136	146	126
124	129	101	76	99	108	109	108	132	90
115	109	78	86	80	109	87	85	77	93
150	133	110	72	119	140	147	185	109	127
115	96	88	81	96	112	152	105	107	134
131	113	120	133	117	132	129	103	148	177
126	159	107	123	117	106	122	104	110	146
134	127	163	130	125	129	147	181	120	137
170	171	188	169	207	220	137	101	110	66
68	92	65	63	44	39	61	41	42	43
60	46	56	58	68	62	73	78	53	57
52	71	87	71	104	57	62	56	62	77
89	68	77	64	67	76	59	52	43	54
51	52	60	69	61	44	54	78	86	98
82	92	123	113	84	146	154	177	128	110
121									

BQ19

116	152	151	137	150	152	147	125	168	142
161	126	144	146	146	134	92	134	113	138
161	129	163	183	159	133	153	127	167	168
157	121	144	105	138	100	104	89	94	143
103	123	162	125	110	118	117	148	169	162
130	134	122	89	78	146	120	78	73	100
106	87	86	113	113	108	90	80	109	81
120	104	119	116	84	89	64	70	80	76
88	94	76	75	97	105	105	93	93	71
88	82	84	64	78	94	92	106	106	105
89	91	83	82	94	73	89	97	88	67
79	100	100	113	111	79	68	120	96	99
99	104	122	86	125	90	102	91	96	118
120	123	108	101	90	95	108	110	111	90
129	113	111	84	117	114	107	108	106	88
100	91	82	125	142	127	123	133	98	127
134	113	120	125	113	85	83	99	87	102
92	107	97	107	110	136	93	84	97	

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