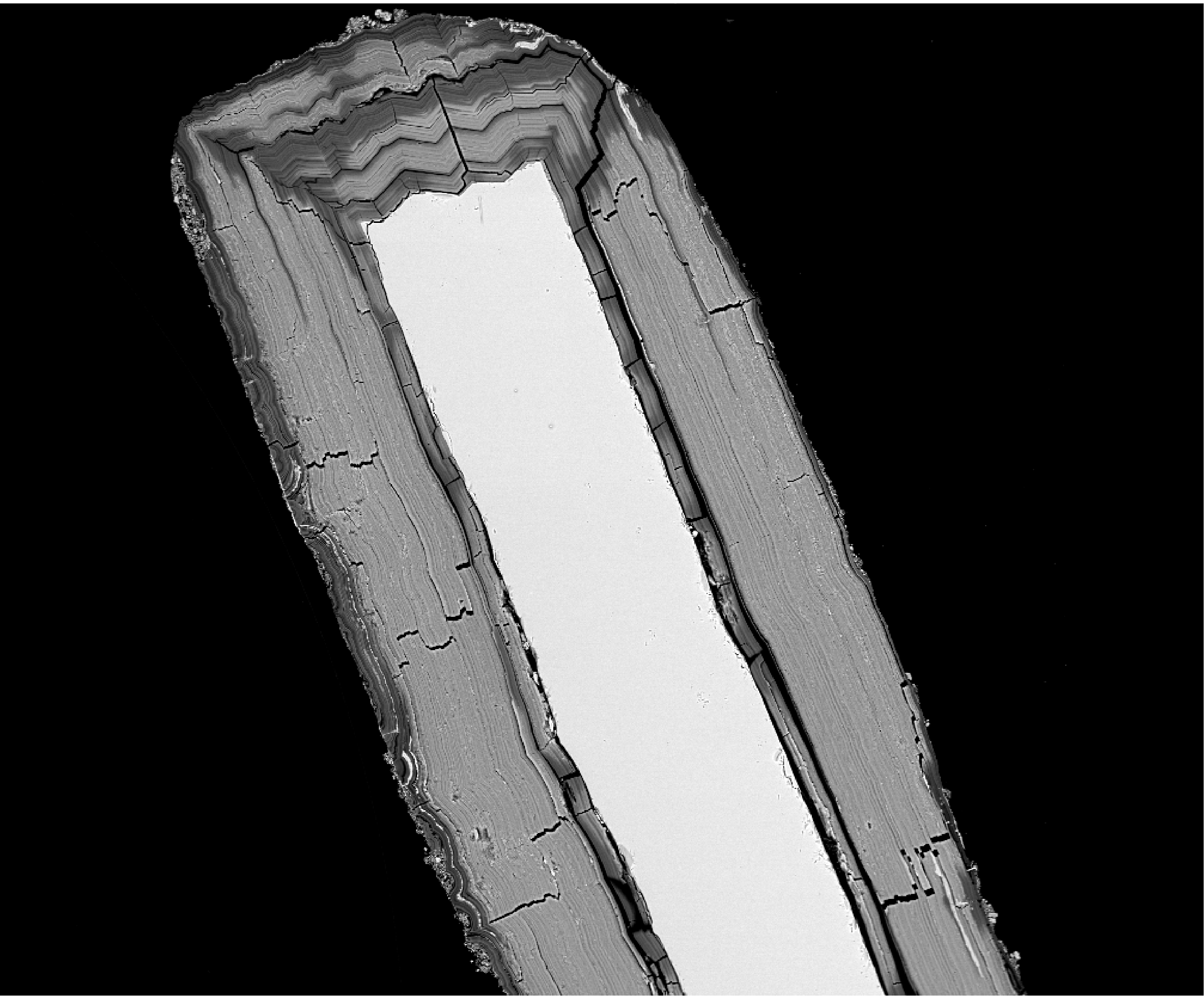
RESEARCH DEPARTMENT REPORT SERIES no. 91-2009 ISSN 1749-8775

BASING GRANGE, OLD BASING AND LYCHPIT, HAMPSHIRE

CHEMICAL ANALYSIS OF EXCAVATED WINDOW GLASS

TECHNOLOGY REPORT

David Dungworth



ARCHAEOLOGICAL SCIENCE

ENGLISH HERITAGE

BASING GRANGE, OLD BASING AND LYCHPIT, HAMPSHIRE

CHEMICAL ANALYSIS OF EXCAVATED WINDOW GLASS

David Dungworth

NGR: SU 6617 5283

ISSN 1749-8775

The Research Department Report Series incorporates reports from all the specialist teams within the English Heritage Research Department: Archaeological Science; Archaeological Archives; Historic Interiors Research and Conservation; Archaeological Projects; Aerial Survey and Investigation; Archaeological Survey and Investigation; Architectural Investigation; Imaging, Graphics and Survey, and the Survey of London. It replaces the former Centre for Archaeology Reports Series, the Archaeological Investigation Report Series and the Architectural Investigation Report Series.
Many of these are interim reports which make available the results of specialist investigations in advance of full publication. They are not usually subject to external refereeing, and their conclusions may sometimes have to be modified in the light of information not available at the time of the investigation. Where no final project report is available, readers are advised to consult the author before citing these reports in any publication. Opinions expressed in Research Department reports are those of the author(s) and are not necessarily those of English Heritage.

Requests for further hard copies, after the initial print run, can be made by emailing:
Res.reports@english-heritage.org.uk
or by writing to:
English Heritage, Fort Cumberland, Fort Cumberland Road, Eastney, Portsmouth PO4 9LD
Please note that a charge will be made to cover printing and postage.

SUMMARY
The analysis of window glass fragments recovered during archaeological excavations on the site of Basing Grange provides information on the chemical composition of glass produced in 1677, when the house was built, and its destruction c1750. All but one fragment of the Basing Grange window glass are high-lime low-alkali glass and most of these share virtually the same composition and so are likely to represent the composition of the glass originally installed in 1677–78.

ACKNOWLEDGEMENTS
I would like to thank David Allen of Hampshire Museums Service who provided the window glass analysed.

ARCHIVE LOCATION
Some of the archive, namely the mounted window glass fragments, are archived at Fort Cumberland, Portsmouth. Other material from the site is archived by Hampshire Museums Service at Chilcomb House, Winchester, Hampshire, SO23 8RD.

DATE OF RESEARCH
2009

CONTACT DETAILS
Fort Cumberland, Fort Cumberland Road, Eastney, Portsmouth, PO4 9LD
David Dungworth, Tel: 023 9285 6783, david.dungworth@english-heritage.org.uk

INTRODUCTION

Basing Grange was built by the Paulet family in 1677 following the restoration of the family estate. The house continued to be a hunting lodge until possibly as late as 1750, by when it had been demolished. Archaeological excavations on the site of Basing Grange uncovered a range of evidence for the nature of this house including a selection of window glass (Allen and Anderson 1999). The window glass was also accompanied by lengths of lead came, some of which had been milled with the date 1677 and 1683. The window glass from Basing Grange must have been produced between 1677 and 1750 and it is likely that a large proportion of the recovered glass was produced close to beginning of this period.

THE WINDOW GLASS

Forty-seven fragments of window glass from the 2000 excavations were made available for scientific study. Thirty-five were unstratified (context 1) and twelve were recovered from context 104. All of the glass was highly weathered with flaky iridescent surfaces but uncorroded glass survived beneath this. The uncorroded glass was all a pale green colour with no discernible colour differences between fragments.

METHODS

All of the fragments of glass were mounted in epoxy resin and ground and polished to a 3-micron finish to expose a cross-section through the glass. The samples were inspected using an optical microscope (brightfield and darkfield illumination) to identify corroded and uncorroded regions. The samples were analysed using two techniques to determine chemical composition: SEM-EDS and EDXRF. The energy dispersive X-ray spectrometer (EDS) attached to a scanning electron microscope (SEM) provided accurate analyses of a range of elements while the EDXRF spectrometer provided improved sensitivity and accuracy for some minor elements. The SEM used was a FEI Inspect F which was operated at 25kV with a beam current of approximately 1nA. The X-ray spectra generated by the electron beam were detected using an Oxford Instruments X-act SDD detector. The quantification of detected elements was achieved using the Oxford Instruments INCA software. The EDS spectra were calibrated (optimised) using a cobalt standard. Deconvolution of the X-ray spectra and quantification of elements was improved by profile optimisation and element standardisation using pure elements and compounds (MAC standards). The chemical composition of the samples is presented in this report as stoichiometric oxides with oxide weight percent concentrations based on likely valence states (the exception being chlorine which is expressed as element wt%). The accuracy of the quantification of all oxides was checked by analysing a wide range reference materials (Corning, NIST, DGG and Newton/Pilkington).

RESULTS

Forty-six of the forty-seven analysed fragments of Basing Grange window glass are high-lime low-alkali (HLLA) glasses. Thirty-one of these forty-six fragments of HLLA glass (samples 3, 5, 7–16, 19–21, 24, 25, 28, 30–32, 34–36, 38–42, 45 and 47) have virtually identical compositions (Figures 1 and 2), that is, the variation in composition was very low and often less than the analytical precision (Table 1). This compositional group represents a major glazing episode and probably the original provision of glass when Basing Grange was constructed in 1677 (Table 1).

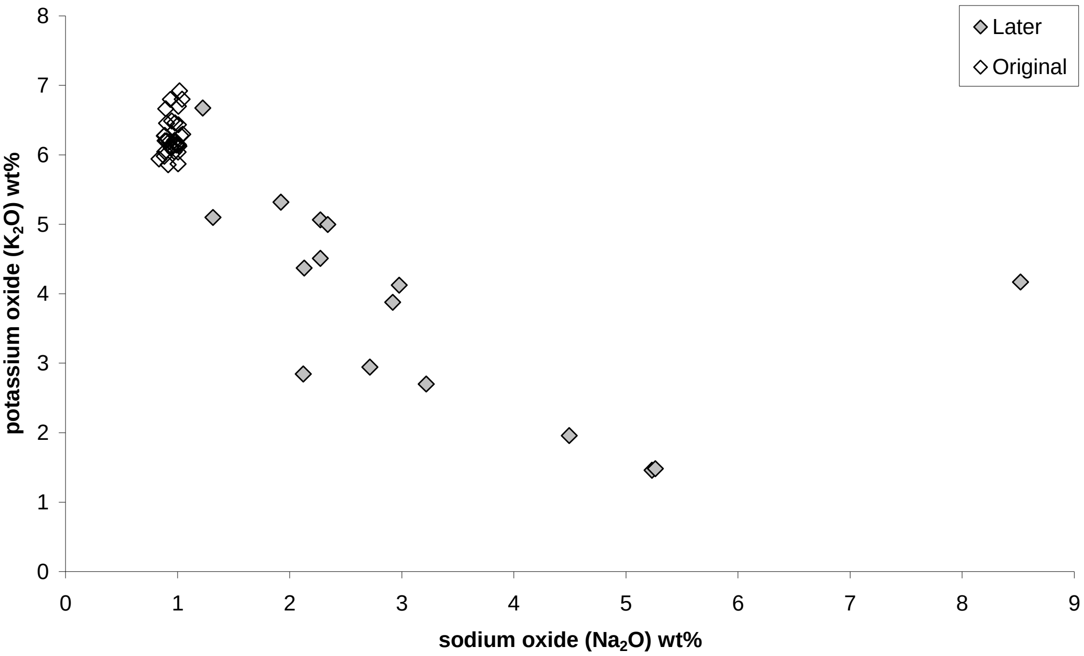


Figure 1. Sodium oxide and potassium oxide content of the Basing Grange window glass

Table 1. Average composition (and standard deviation) of the probable original Basing House glass (1677–8)

Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	Cl	K_2O	CaO	TiO_2	MnO	Fe_2O_3	SrO	ZrO_2
1.0	2.0	2.5	60.3	2.1	0.5	0.14	6.3	23.8	0.16	0.15	1.2	0.06	0.014
±0.1	±0.2	±0.2	±1.2	±0.1	±0.1	±0.02	±0.3	±1.0	±0.03	±0.05	±0.1	±0.01	±0.004

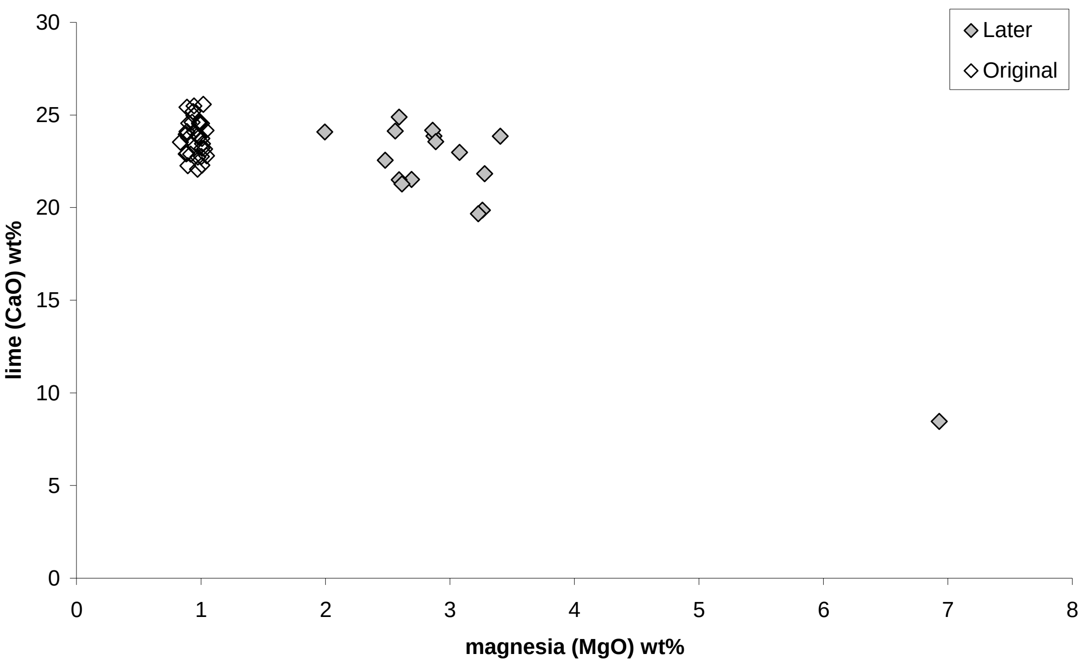


Figure 2. Magnesia and lime content of the Basing Grange window glass

The remaining fifteen samples of HLLA glasses display considerable compositional variation and most likely represent occasional replacement of damaged windows during the 60 year life of the house. Three pairs of these samples (2 and 37, 6 and 17, and 23 and 27) share almost identical compositions. The last fragment (sample 4) is a mixed alkali with a high strontium content which suggests that it was manufactured using seaweed ash (kelp). Previous research (Dungworth and Loaring 2009) suggests that window glass made using seaweed ash did not become common until the beginning of the 18th century.

DISCUSSION

The glass represented by the composition in Table 1 is probably that installed during the construction of Basing Grange (1677). This is a HLLA glass which has a broadly similar composition to that of other 17th-century window glass, such as Basing House (Dungworth in preparation a), Chastleton House (Mortimer 1993), Shaw House (Dungworth and Loaring 2009) and Palace House Mansion (Bayley *et al* 2009). The composition of the Basing Grange window glass confirms that in the late 17th century HLLA glass remained the most widely used type of glass for window glazing. Only one fragment of window glass (BG04) is of a composition which would place its manufacture after the beginning of the 18th century.

The Basing Grange HLLA window glass contains modest levels of manganese (on average 0.15wt% MnO) which are comparable with the results from the broadly contemporary windows at Palace House Mansion (Bayley et al 2009) but contrasts with the higher levels (on average 0.7wt% MnO) found in late 16th-century HLLA glass (Dungworth and Clark 2004). The analysis of Shaw House HLLA window glass (which could not be more precisely dated that 1581–c1700) showed the presence of both high- and low-manganese HLLA glass, but none with intermediate concentrations (Dungworth and Loaring 2009). It is tempting to suggest that high-manganese HLLA glass dates to the earlier part of the period 1567–1700 and that low-manganese HLLA glass dates to the later part of this period. The analysis of glassworking debris from Newent (Dungworth in preparation b) which was in operation during the last decade of the 16th century and first decade of the 17th century shows an average manganese content of 0.37wt% MnO (that is, intermediate between the late 16th-century HLLA glass and the late 17th-century glass). Thus the possible change from a high-manganese to a low-manganese HLLA glass may have occurred around 1600.

REFERENCES

Allen, D and Anderson, S 1999 *Basing House, Hampshire. Excavations 1978–1991*. Winchester: Hampshire Field Club and Archaeological Society

Bayley, J, Doonan, R and Dungworth, D 2009 'Palace House Mansion: the earliest sash window?', in Gabrielle, S and Philippe, M (Eds) *Verre et Fenêtre de l'Antiquité au XVIIIe Siècle*. Paris: Verre et Histoire, 207–210

Dungworth, D in preparation a *Basing House, Old Basing and Lychpit, Hampshire. Chemical Analysis of the Window Glass*. Research Department Report. Portsmouth: English Heritage

Dungworth, D in preparation b *Newent Glasshouse, Newent, Gloucestershire. Investigation of glass and glassworking debris*. Research Department report. Portsmouth: English Heritage

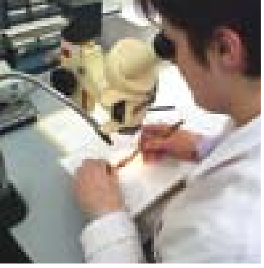
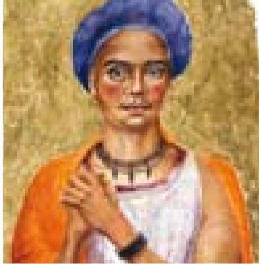
Dungworth, D and Clark, C 2004 *SEM-EDS Analysis of Wealden Glass*. Centre for Archaeology Report 54/2004. Portsmouth: English Heritage

Dungworth, D and Loaring, A 2009 *Shaw House, Newbury, Berkshire. An Investigation of the Window Glass*. Research Department Report 57/2009. Portsmouth: English Heritage

Mortimer, C 1993 *Analysis of Window Glass from Chastleton House, Oxfordshire*. Ancient Monuments Laboratory Report 117/1993. London: English Heritage.

APPENDIX: CHEMICAL COMPOSITION OF ANALYSED SAMPLES

Sample	Accession	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	Cl	K_2O	CaO	TiO_2	MnO	Fe_2O_3	SrO	ZrO_2	BaO
BG001	A2000.1	2.71	3.40	2.09	60.71	1.85	0.59	0.34	2.94	23.85	0.15	0.17	1.06	0.14	0.02	<0.1
BG002	A2000.1	2.98	2.86	2.30	58.82	1.92	0.56	0.57	4.12	24.17	0.16	0.17	1.49	0.20	0.02	<0.1
BG003	A2000.1	0.94	1.91	2.63	58.48	2.10	0.61	0.14	6.12	25.49	0.17	0.15	1.28	0.07	0.02	<0.1
BG004	A2000.1	8.52	6.93	2.64	66.70	1.19	0.31	0.12	4.17	8.46	0.12	0.07	0.99	0.53	0.03	0.11
BG005	A2000.1	0.94	2.00	2.33	58.36	2.23	0.56	0.13	6.80	25.18	0.13	0.15	1.16	0.06	0.01	<0.1
BG006	A2000.1	5.26	3.23	3.71	61.13	2.10	0.12	1.10	1.48	19.67	0.30	0.80	1.16	0.09	0.03	0.24
BG007	A2000.1	0.89	2.41	2.18	61.21	2.14	0.51	0.13	6.66	22.26	0.17	0.23	1.17	0.07	0.01	<0.1
BG008	A2000.1	0.94	2.01	2.64	59.20	1.96	0.54	0.11	6.10	24.96	0.15	0.14	1.18	0.06	0.01	<0.1
BG009	A2000.1	0.93	1.77	2.65	60.12	1.88	0.49	0.14	6.19	24.60	0.10	0.08	1.04	0.07	0.01	<0.1
BG010	A2000.1	0.97	2.06	2.22	61.52	2.15	0.43	0.16	6.21	22.72	0.16	0.15	1.28	0.06	0.01	<0.1
BG011	A2000.1	1.00	2.08	2.32	59.67	2.25	0.46	0.14	6.04	24.54	0.14	0.16	1.21	0.06	0.02	<0.1
BG012	A2000.1	0.89	1.98	2.30	61.47	2.11	0.40	0.12	6.20	22.93	0.18	0.17	1.29	0.06	0.02	<0.1
BG013	A2000.1	1.01	1.94	2.52	60.84	2.08	0.48	0.15	6.13	23.45	0.19	0.12	1.15	0.06	0.01	<0.1
BG014	A2000.1	0.98	1.94	2.42	60.67	2.02	0.44	0.13	6.18	23.79	0.19	0.11	1.15	0.06	0.02	<0.1
BG015	A2000.1	0.99	1.85	2.63	60.09	1.87	0.49	0.14	6.14	24.59	0.14	0.08	1.02	0.06	0.01	<0.1
BG016	A2000.1	1.01	2.14	2.35	60.48	2.13	0.48	0.14	6.43	23.19	0.16	0.23	1.22	0.07	0.02	<0.1
BG017	A2000.1	5.23	3.26	3.77	60.97	2.03	0.04	1.15	1.46	19.86	0.27	0.82	1.02	0.06	0.01	0.21
BG018	A2000.1	3.22	2.89	1.74	61.94	1.79	0.38	0.52	2.70	23.56	0.12	0.19	1.06	0.17	0.01	<0.1
BG019	A2000.1	1.04	2.31	2.86	58.52	2.05	0.59	0.12	6.80	24.17	0.18	0.22	1.19	0.07	0.02	<0.1
BG020	A2000.1	0.97	2.26	2.69	61.67	2.16	0.31	0.13	6.05	22.07	0.21	0.20	1.15	0.07	0.02	0.10
BG021	A2000.1	0.99	1.84	2.73	59.60	1.98	0.51	0.16	6.15	24.52	0.16	0.11	1.20	0.06	0.01	<0.1
BG022	A2000.1	4.49	3.08	3.31	59.73	2.27	0.26	0.10	1.96	22.97	0.25	0.55	0.97	0.08	0.03	0.18
BG023	A2000.1	2.34	2.62	2.52	61.41	2.15	0.45	0.37	5.00	21.28	0.24	0.22	1.45	0.10	0.02	<0.1
BG024	A2000.1	0.89	1.72	2.60	60.96	1.76	0.56	0.13	6.04	24.10	0.13	0.07	1.01	0.06	0.01	<0.1
BG025	A2000.1	0.90	1.97	2.49	60.21	2.20	0.51	0.12	6.45	23.78	0.13	0.12	1.18	0.06	0.01	<0.1
BG026	A2000.1	1.32	2.56	2.98	58.68	2.23	0.43	0.27	5.10	24.13	0.25	0.35	1.71	0.09	0.02	0.10
BG027	A2000.1	2.27	2.59	2.53	61.32	2.13	0.45	0.35	5.06	21.50	0.17	0.22	1.50	0.11	0.02	<0.1
BG028	A2000.1	0.98	2.02	2.42	60.18	1.91	0.56	0.16	6.46	23.91	0.16	0.10	1.17	0.07	0.02	<0.1
BG029	A2000.1	2.27	2.48	2.33	61.29	2.03	0.45	0.35	4.51	22.55	0.21	0.22	1.36	0.10	0.02	<0.1
BG030	A2000.1	0.92	2.14	2.25	61.53	2.18	0.43	0.17	5.86	22.88	0.15	0.18	1.24	0.07	0.02	0.10
BG031	A2000.1	1.00	2.05	2.32	61.85	2.10	0.35	0.13	5.87	22.76	0.17	0.14	1.28	0.05	0.01	<0.1
BG032	A2000.1	0.88	1.68	2.64	61.18	1.79	0.51	0.14	5.98	23.95	0.11	0.07	1.05	0.06	0.01	<0.1
BG033	A2000.1	1.92	2.69	2.47	61.46	1.83	0.57	0.35	5.32	21.52	0.20	0.14	1.44	0.11	0.02	0.14
BG034	A2000.1	0.83	1.94	2.17	61.48	1.99	0.52	0.14	5.94	23.53	0.15	0.15	1.23	0.07	0.02	<0.1
BG035	A2000.1	1.01	2.21	2.66	61.45	2.17	0.27	0.17	6.15	22.28	0.19	0.26	1.22	0.08	0.02	<0.1
BG036	A2000.104	0.88	1.90	2.33	61.49	2.03	0.60	0.12	6.27	22.90	0.17	0.15	1.17	0.06	0.01	<0.1
BG037	A2000.104	2.92	2.87	2.38	59.55	1.75	0.57	0.51	3.88	23.86	0.19	0.15	1.40	0.16	0.01	<0.1
BG038	A2000.104	1.03	1.98	2.17	61.24	2.01	0.54	0.22	6.28	23.16	0.15	0.11	1.08	0.05	0.01	<0.1
BG039	A2000.104	1.01	2.20	2.57	59.22	2.19	0.51	0.14	6.70	23.73	0.18	0.16	1.37	0.06	0.02	<0.1
BG040	A2000.104	1.04	2.10	2.09	61.42	2.06	0.50	0.16	6.30	22.79	0.17	0.16	1.25	0.08	0.02	<0.1
BG041	A2000.104	0.95	2.00	2.37	59.83	2.16	0.52	0.14	6.49	24.10	0.15	0.14	1.18	0.06	0.01	<0.1
BG042	A2000.104	0.90	1.82	2.63	60.14	1.93	0.51	0.14	6.20	24.55	0.10	0.07	1.01	0.06	0.01	<0.1
BG043	A2000.104	1.22	2.00	2.92	59.24	1.98	0.40	0.16	6.67	24.09	0.11	0.09	0.93	0.03	0.01	<0.1
BG044	A2000.104	2.13	3.28	3.36	59.52	2.50	0.16	0.30	4.37	21.84	0.26	0.87	1.30	0.08	0.02	0.21
BG045	A2000.104	1.02	2.18	2.37	57.51	2.30	0.56	0.11	6.92	25.57	0.13	0.13	1.11	0.06	0.01	<0.1
BG046	A2000.104	2.12	2.59	2.75	59.72	1.78	0.58	0.39	2.84	24.89	0.21	0.25	1.98	0.12	0.02	<0.1
BG047	A2000.104	0.89	1.91	2.56	58.92	2.02	0.56	0.12	6.28	25.42	0.15	0.11	1.04	0.07	0.01	<0.1



ENGLISH HERITAGE RESEARCH DEPARTMENT

English Heritage undertakes and commissions research into the historic environment, and the issues that affect its condition and survival, in order to provide the understanding necessary for informed policy and decision making, for sustainable management, and to promote the widest access, appreciation and enjoyment of our heritage.

The Research Department provides English Heritage with this capacity in the fields of buildings history, archaeology, and landscape history. It brings together seven teams with complementary investigative and analytical skills to provide integrated research expertise across the range of the historic environment. These are:

- *Aerial Survey and Investigation*
- *Archaeological Projects (excavation)*
- *Archaeological Science*
- *Archaeological Survey and Investigation (landscape analysis)*
- *Architectural Investigation*
- *Imaging, Graphics and Survey (including measured and metric survey, and photography)*
- *Survey of London*

The Research Department undertakes a wide range of investigative and analytical projects, and provides quality assurance and management support for externally-commissioned research. We aim for innovative work of the highest quality which will set agendas and standards for the historic environment sector. In support of this, and to build capacity and promote best practice in the sector, we also publish guidance and provide advice and training. We support outreach and education activities and build these in to our projects and programmes wherever possible.

We make the results of our work available through the Research Department Report Series, and through journal publications and monographs. Our publication Research News, which appears three times a year, aims to keep our partners within and outside English Heritage up-to-date with our projects and activities. A full list of Research Department Reports, with abstracts and information on how to obtain copies, may be found on www.english-heritage.org.uk/researchreports

For further information visit www.english-heritage.org.uk

ENGLISH HERITAGE