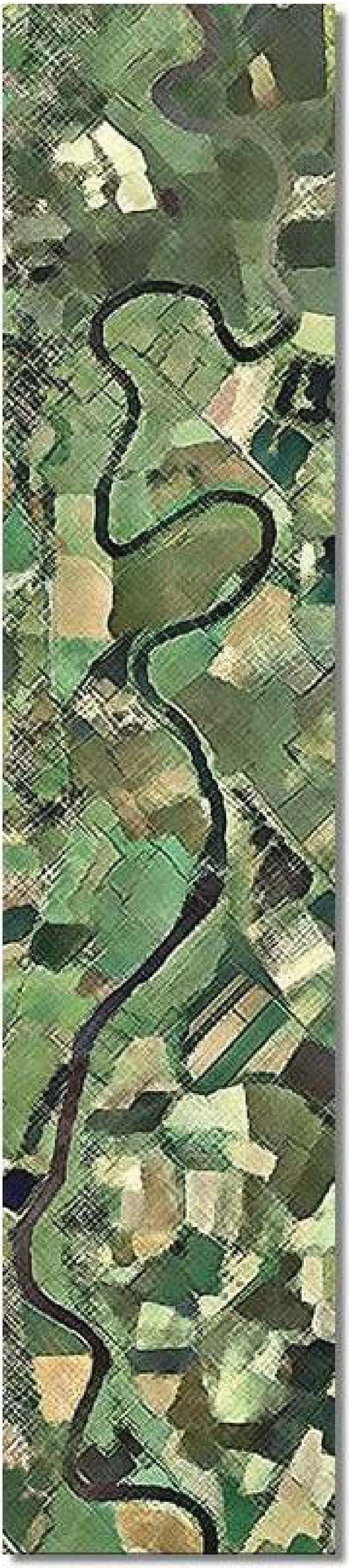

YORK ARCHAEOLOGICAL TRUST

Trent Valley GeoArchaeology 2002

Component 3: Alluvium Depth and Character Modelling

Principal Investigator: Keith Challis
York Archaeological Trust

Funded by English Heritage from the Aggregates Levy Sustainability Fund

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PNUM 3307

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Modelling the depths of alluvium in relation to the gravels and palaeochannels is an important guide to the physical development of the floodplain and the past behaviour of the Trent. It contributes to the understanding of patterns in settlement and land use, aids the prediction and management of deposits containing well-preserved organic remains and is a consideration in risk management. Alluvium depth models are derived from borehole data held by the British Geological Survey and mineral operators related to map data within GIS and 3D modelling packages. Modelling of alluvium has been undertaken for the Trent floodplain in Nottinghamshire. Using the techniques established by this work, coverage will be extended to cover the whole Trent Valley area.

(Project Outline May 2002)

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1 INTRODUCTION

1.1 Component Aims

This component of Trent Valley GeoArchaeology 2002 aims to address the imbalance in documentation and understanding of the geoarchaeology of the floodplain by producing comprehensive character data for the alluvial deposits of the River Trent in a durable Geographical Information System (GIS) format. These data will provide a new information source for the Sites and Monuments Records (SMR) of participating local authorities to assist in the strategic management of the geoarchaeological resource of the Trent.

The objectives are:

- A GIS-based catalogue of borehole data for the floodplain alluvium of the study area that may be integrated with existing GIS data and data structures (for example the SMRs of participating local authorities).

- GIS derived maps showing the broad character of the alluvial deposits for the entire study area (at a catchment scale), including for example mapping the thickness of alluvial deposits and the distribution of peat deposits within alluvium as a guide to the presence of palaeochannels.

- Production of sub-surface digital elevation models (DEM) of significant stratigraphic horizons at reach scale to attempt to identify and map key topographical features such as buried palaeochannels.

1.2 About this Report

This report provides details of the data collection method and a summary of the results for this project component. Section 2 comprises a brief discussion of issues relating to data availability and quality together with an outline of the data model adopted for digitisation of borehole records. Section 3 is a brief discussion of issues relating to the generation of three-dimensional sub-surface DEM from borehole observations.

Section 4 provides a summary of the results for each of the six survey reaches comprising the study area. In several areas borehole observations were sufficiently dense to allow three-dimensional modelling of sub-surface deposits; where this is so the results are illustrated and discussed.

Section 5 provides a number of conclusions and recommendations to guide future work.

The appendix provides technical details of the accompanying CD-ROM archive of borehole records.

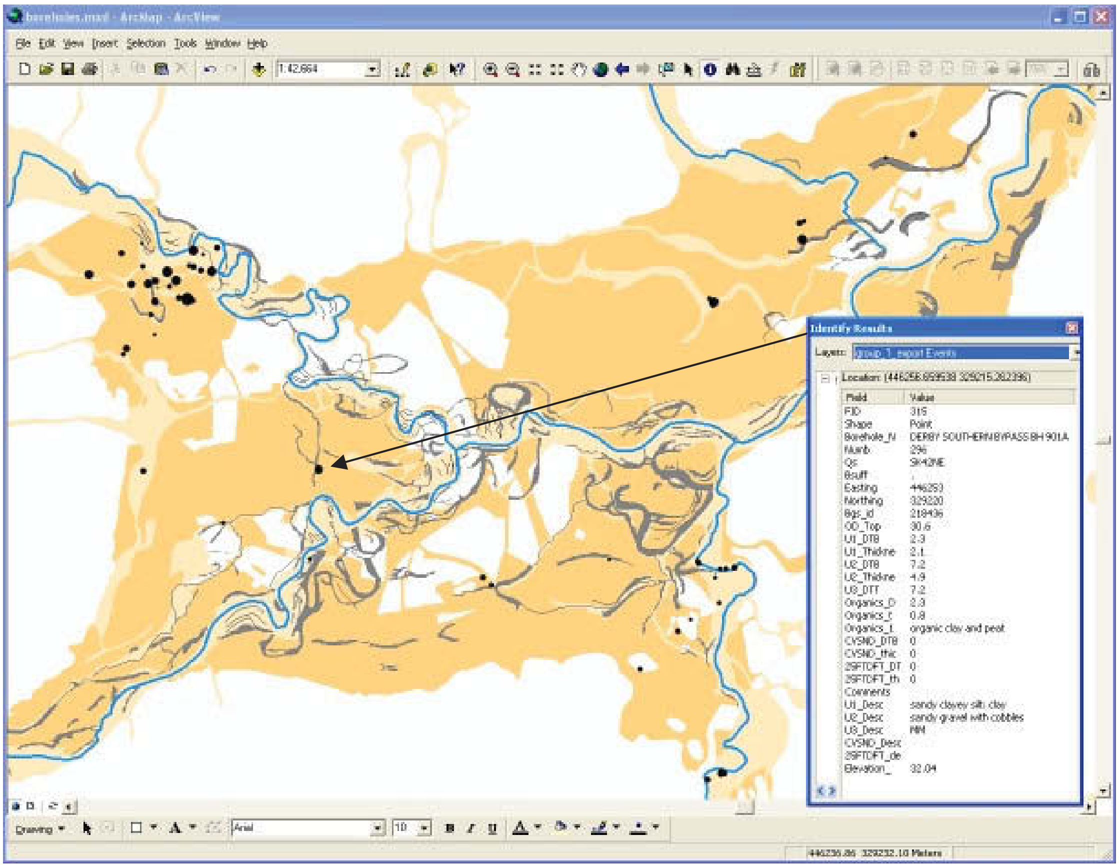


Figure 1. Screen-shot from ArcGIS showing the borehole database in use in combination with geological mapping from British Geological Survey and palaeochannel plots produced by Steve Baker at Trent & Peak Archaeological Unit. The borehole data has been displayed to show proportional circles indicating the locations and thickness of peat deposits. The information box on this right shows the details of the selected borehole record.

2 BOREHOLE DATA FOR THE TRENT VALLEY

2.1 Availability of Borehole Data

Logs of boreholes within the study area are held at the National Geological Data Centre (NGDC), at the British Geological Survey, Keyworth, Nottinghamshire. Paper copies of the original logs are kept in box files, indexed by Ordnance Survey 1:10,000 quarter sheet. The NGDC also hold a digital index for the data, comprising national grid reference and other summary information for each paper log. In order to identify the borehole records required for the study, the digital index data, supplied as an ASCII file, was spatially queried within a GIS to list only those boreholes within the floodplain alluvium and lower terraces of the Trent. Where publicly available the log for each of these boreholes was examined and relevant details catalogued in a database.

2.2 Borehole Data Quality

The quality of borehole logs is often highly variable. A good log might include measurement of depth, Ordnance Datum (OD) level and thickness of observed strata, descriptions of lithology and interpretation assigning the observed strata to recognised stratigraphic units (alluvium, terrace, etc.). Older logs often lack lithographic descriptions or include questionable interpretations. In some areas geological prospection boreholes made for the coal industry made no detailed record of superficial deposits, while many well records, often dating from the 19th and early 20th centuries, include no, or only poor, records of geology.

The use of borehole data within a GIS requires the digitising of paper-based borehole records using a coherent and consistent data model. Where used for three-dimensional sub-surface modelling digitising is followed by the interpolation of continuous surfaces from the data and the checking and analysis of the surfaces generated.

2.3 A Data Model

In order to use such heterogeneous data a universally applicable data model, describing the stratigraphy of the study area, was developed. The relatively diffuse spatial distribution of most borehole data means that it is generally necessary to adopt a relatively simple data model and to record for modelling only substantial, spatially contiguous stratigraphic elements. Within the Trent Valley the data model adopted usually records details of at least four stratigraphic units:

Unit 1: fine grained silt and clay alluvium
Unit 2: coarse grained sand and gravel alluvium
Unit 3: bedrock
Unit 4: organic deposits such as peat

Additional stratigraphic units, such as the lacustrine or aeolian deposits common in parts of the Lower Trent Valley, or finer stratigraphic distinctions, such as local variations in the character of fine-grained alluvial cover, can be added where appropriate. The data structure developed to store this information is presented in appendix 1. The accompanying CD-ROM contains an archive of borehole data for the study area in a variety of proprietary digital formats.

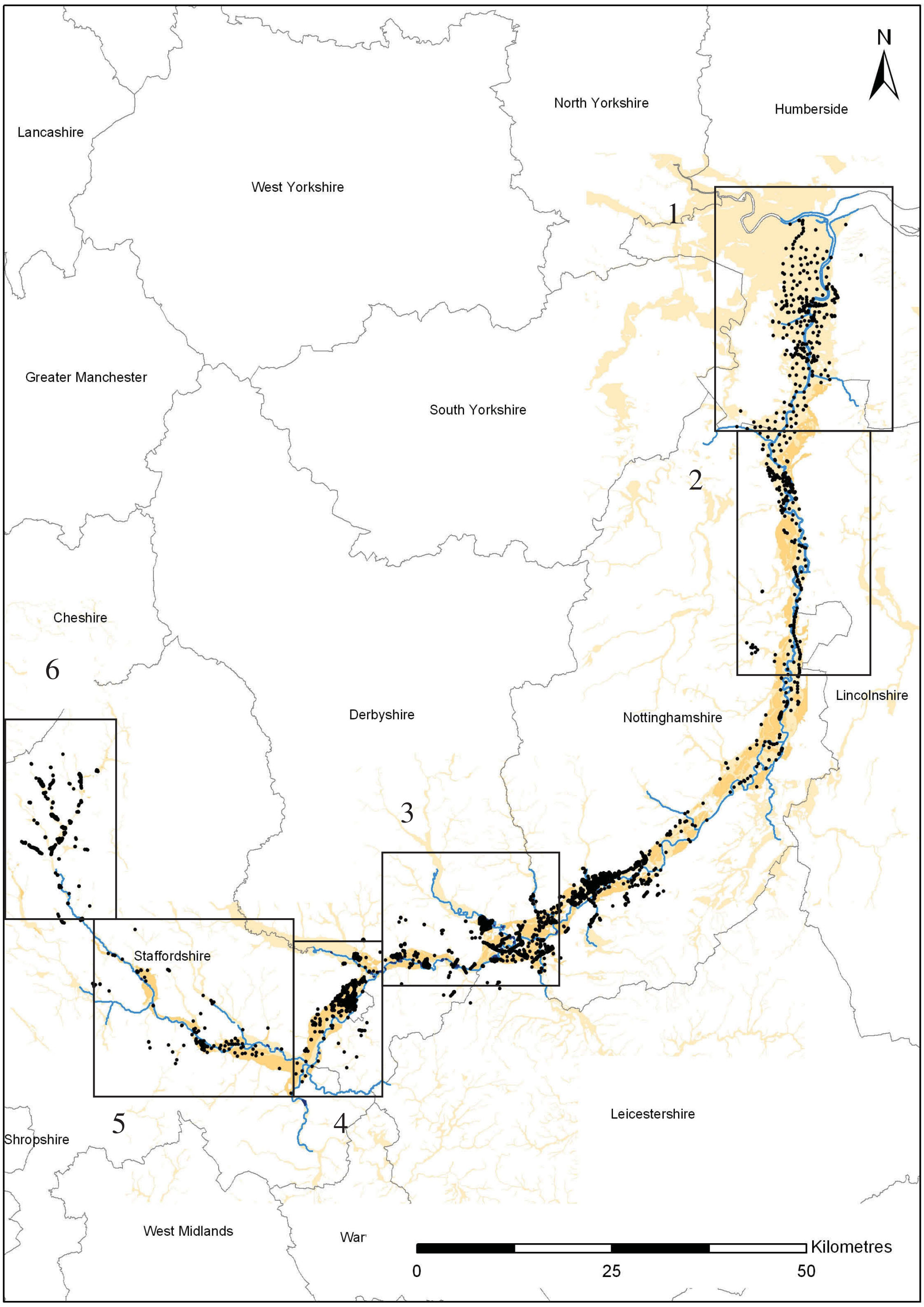


Figure 2. Map showing the extent of the floodplain and lower terraces of the Trent and the locations of all borehole records examined as part of the Trent Valley GeoArchaeology study (including those examined as part of the 2001 study for Nottinghamshire County Council). TVG2002 study reaches, discussed in section 4, are shown in outline.

2.4 Summary of Collected Data

In total 4384 borehole record for the floodplain and younger terraces of the Trent have been examined and digitised as part of the project (Figure 2; 2774 as part of TVG2002 and 1610 during the 2001 Nottinghamshire study). Table 1 summarises the borehole data collected as part of these studies.

Table 1 Summary of borehole observations for the study area.

	Total Observations	Notts Project	TVG 2002
Unit 1: Alluvium	1842	798	1044
Unit 2: Sand and Gravel	2345	1032	1313
25ft drift	12	Not distinguished	12
Organics	378	176	202
Unit 3: Rockhead	1830	804	1026
Total boreholes	4384	1610	2774

Most significantly organic deposits such as peat and other organic sediments were identified in 378 boreholes (Table 2 and Figure 3). The distribution of peat deposits provides a ready indicator of palaeoecological potential across the valley floor. Where used in conjunction with the maps of palaeochannels produced by Steve Baker of Trent & Peak Archaeological Unit (Baker 2003) borehole records of peat may assist in determining the palaeoecological potential of specific palaeochannels (Figure 4). It is also worth noting the borehole records of peat in areas where no palaeochannels have been mapped might indicate the presence of further buried channels, or in some instances of more substantial buried landscapes (for example in the Lower Trent Valley north of the River Idle; Figure 8).

Table 2 Locations and character of organic sediments in the TVG2002 study area.

BGS Reference	Borehole Name	NGRE	NGRN	Thickness	Description
SE81SW37	A18 SCUNTHORPE 18	480150	412750	0.4	Peat
SE81SW39	A18 SCUNTHORPE 20	481660	412980	0.1	Peat
SE81SW40	A18 SCUNTHORPE 21	482330	413210	0.45	Peat
SE81SW41	A18 SCUNTHORPE 22	482800	413130	0.2	Peat
SE81SW42	A18 SCUNTHORPE 23	483350	413050	2	Peat
SE81SW43	A18 SCUNTHORPE 24	483890	412800	3.35	Peat
SE81SW46	A18 SCUNTHORPE 27	484930	412450	2	Clayey Peat
SE80NW34	A18 SCUNTHORPE 71	483360	405330	7.25	Peat And Peaty Clay`
SE81SW47	A18 SCUNTHORPE 95	482050	410010	2.6	Peat
SE81SW48	A18 SCUNTHORPE 96	482580	410190	6.3	Clayey Peat
SE81SW49	A18 SCUNTHORPE 97	483060	410350	5.9	Peat
SE81SE34	A18 THORNE/SCUNTHORPE BH 28	485820	412400	4.1	Peat: Clayey Peat
SE80NW39	A18 THORNE/SCUNTHORPE BH 50	482200	407190	8	Peat
SE80NW40	A18 THORNE/SCUNTHORPE BH 51	482740	407240	6.1	Peat
SE80NW41	A18 THORNE/SCUNTHORPE BH 54	483920	407500	3.5	Peat
SE80NW44	A18 THORNE/SCUNTHORPE BH 69	482220	406000	7.15	Peat
SE80NW46	A18 THORNE/SCUNTHORPE BH 73	484320	405150	5.1	Peat And Peaty Clay
SE80NW47	A18 THORNE/SCUNTHORPE BH 94	481080	409880	2.65	Peat
SE80NW52	A18 THORNE-SCUNTHORPE BHL1	484680	407590	2	Peat
SE80NW53	A18 THORNE-SCUNTHORPE BHL2	484770	408440	2.9	Peat: Clay And Peat
SE80NW54	A18 THORNE-SCUNTHORPE BHL3	484910	408920	3.95	Peat
SE80NE122	A18 THORNE-SCUNTHORPE BHL4	485220	409580	4.1	Peat
SE81SE202	A18 THORNE-SCUNTHORPE BHL6	485610	410680	1.5	Peat
SE81SE204	A18 THORNE-SCUNTHORPE BHL8	485950	411130	1	Peat
SK42NW158	A564 DERBY S BYPASS SPUR BH121	443044	329902	0.3	Peat
SK42NW175	A564 DERBY S BYPASS SPUR TP220	444116	329447	0.3	Silty Organic Clay With Timber
SK42NW178	A564 DERBY S BYPASS SPUR TP223	444468	329424	0.15	Sandy Organic Clay With Timber Fragments
SK32NE326	A564 DERBY SOUTH'BYPASS BH607	437450	329510	0.1	Peat
SK32NE328	A564 DERBY SOUTH'BYPASS BH608A	437460	329485	0.5	Clayey Peat
SK23SE212	A564 DERBY SOUTH'BYPASS TP426	426482	330876	0.7	Peat
SK33SW131	A564 DERBY SOUTH'BYPASS TP526	431770	330395	0.1	Peat
SK33SE253	A564 DERBY SOUTH'BYPASS TP5326	439617	333281	0.5	Peat
SK32NE330	A564 DERBY SOUTH'BYPASS TP610	437428	329463	0.95	Peat
SK32NE333	A564 DERBY SOUTH'BYPASS TP615	437476	329502	0.4	Peat
SE80NW8	ALTHORPE	482540	409630	5	Peaty Silt
SE80NW18	BELTOFT	481920	406780	0.4	Silty Peat
SE80NW15	BELTOFT GRANGE	481690	407710	0.7	Silty Peat
SE80SE63	BLACK BANK FARM	486080	403232	7	Peat
SE80SW15	BLACK DRAIN	482030	403327	6.6	Silt: Peat: Roots & Leaves At Base

BGS Reference	Borehole Name	NGRE	NGRN	Thickness	Description
SK22SW164	B-ON-TRENT PROPOSED NTN LK A38 BH24A	424920	323670	0.3	Clayey Peat With Wood
SK22SW165/B	B-ON-TRENT PROPOSED NTN LK A38 BH24B	424950	323640	0.25	Peat
SJ92NW17	BOROUGH OF STAFFORD BH NO A	391860	325170	3.81	Peat
SJ92NW18	BOROUGH OF STAFFORD BH NO B	392070	325150	1.7	Very Peaty Clay Becoming Peat
SJ92SW5	BOROUGH OF STAFFORD BH NO 'C'	391870	324920	1.4	Silty Clayey Peat
SE80NW10	BRUMBY COMMON WEST	484630	409610	6.5	Peaty Silt
SE80NW14	BURRINGHAM	484160	408800	7.4	Peaty Silt
SE80NW17	BURRINGHAM	483630	407620	6.8	Peaty Silt
SK22SE154	BURTON ON TRENT E/W SECTION BH236	425250	322100	0.3	Sandy Peaty Silt With Decaying Vegetation
SK22SE155	BURTON ON TRENT E/W SECTION BH238	425230	322060	1.4	Organic Lay And Silt
SK22SE89	BURTON ON TRENT NEW BRIDGE PHASE 1 BH18	425400	322230	1.5	Clayey Sand With Gravel And Peat
SK22SE93	BURTON ON TRENT NEW BRIDGE PHASE 1 BH23	425430	322280	2	Silt And Sandy Silt With Wood Fragments
SK22SE95	BURTON ON TRENT NEW BRIDGE PHASE 1 BH25	425470	322290	1.68	Silty Sandy Clay With Wood Fragments
SK22SE97	BURTON ON TRENT NEW BRIDGE PHASE 1 BH27	425380	322320	0.15	Peat
SK22SE98	BURTON ON TRENT NEW BRIDGE PHASE 1 BH28	425320	322300	0.3	Clay-Peat
SK22SE109	BURTON ON TRENT NEW BRIDGE PHASE 1 BH44	425150	322060	0.3	Peat
SK22SE134	BURTON ON TRENT PROPOSED NTH LK BH26	425010	323730	0.65	Clayey Peat
SK22SW162	BURTON ON TRENT PROPOSED NTN LK A38 BH21	424870	323560	0.4	Peat
SK22SW163	BURTON ON TRENT PROPOSED NTN LK A38 BH22	424880	323600	0.2	Peat
SK22SW109	BURTON UPON TRENT BH7H	424210	324540	0.4	Silty Clay With Peat Bands
SK22NE41	BURTON UPON TRENT LOW LEVEL BH.LL18A	426240	325650	0.9	Silty Peat
SK22NE37	BURTON UPON TRENT LOW LEVEL BH15LL	425940	325200	0.6	Peat
SK22NE38	BURTON UPON TRENT LOW LEVEL BH16LL	426030	325360	0.9	Peat
SK12SE27	BURTON-ON-TRENT 20	419890	320490	0.15	Peat
SJ84NE2113	CANAL ST, LONGPORT EMS TP1	385490	349680	0.3	Organic Silty Clay And Peat
SJ84NE2114	CANAL ST, LONGPORT EMS TP2	385470	349710	0.1	Organic Silty Clay
SJ84NE2116	CANAL ST, LONGPORT EMS TP4	385490	349750	0.4	Organic Silty Clay And Peat
SJ84NE2117	CANAL ST, LONGPORT EMS TP5	385500	349710	0.6	Organic Silty Clay With Organic Material
SK79SE13	CARR LANE : EAST STOCKWITH	479853	394422	1.8	Peat
SK22NE42	CLAY MILLS BURTON ON TRENT BH3	426350	325740	0.6	Peat
SK22NE17/A	CLAY MILLS SEWAGE WORKS 1	426210	325770	0.6	Peat
SK22NE17/K	CLAY MILLS SEWAGE WORKS 10	426570	325940	0.6	Peat
SE80NW58	CORRINGHAM 77	484140	405270	6.1	Clay And Peat
SE80NW59	CORRINGHAM 78	484260	405600	7.92	Peat
SE80NW60	CORRINGHAM 79	484250	405850	6.1	Clay And Peat
SE81NW28	COTLEY HALL AMCOTTS	484730	415770	0.9	Peat
SK87SW39	COTTAM - WYMONDLEY POWER LINE BH 24	481705	371345	1.1	Peat
SK87SW40	COTTAM - WYMONDLEY POWER LINE BH 25	481674	370934	0.3	Peat
SK42NE296	DERBY SOUTHERN BYPASS BH 901A	446253	329220	0.8	Organic Clay And Peat
SK42NE297	DERBY SOUTHERN BYPASS BH 901B	446353	329120	0.45	Silty Peaty Clay
SE80NW13	DERRYTHORPE	482850	408680	9.8	Peaty Silt
SE80NW12	DERRYTHORPE COMMON	482150	408800	5.6	Peaty Silt
SE80NW16	DERRYTHORPE GRANGE	482410	407620	5.9	Silt And Peat
SE80NW62	DONCASTER 160	483000	405620	9.14	Peat
SE80NW63	DONCASTER 161	482630	405780	9.14	Peat
SE80NW64	DONCASTER 162	482310	405990	9.14	Sand And Peat
SE81SW6	DONCASTER ROAD GUNNESS	484970	411450	8.5	Peat
SE81SW5	DONCASTER ROAD GUNNESS	484920	411460	8.84	Peat
SE80NW20	EAST BUTTERWICK	484060	406860	8	Peaty Silt
SE80NW4	EAST BUTTERWICK BH	483820	406130	5.34	Peat And Sandy Peat
SE81NW25	EASTOFT	481710	415400	1	Peat
SK79SE14	FERRY ROAD: WALKERINGHAM	478411	393054	5	Peat With Clay And Reed Fragments
SE81SE48	FLIXBOROUGH BH 10	486980	413750	1.3	Peat
SE81SE49	FLIXBOROUGH BH 11	487100	413720	0.6	Peat
SE81SE42	FLIXBOROUGH BH 4	486720	414400	1.2	Peat And Clay With Sandy Peat
SE81SE45	FLIXBOROUGH BH 7	486960	414200	0.5	Sand With Peat
SE81SE46	FLIXBOROUGH BH 8	487010	414100	1.5	Peat
SE81SE47	FLIXBOROUGH BH 9	486980	413860	1.1	Peat
SE81SE219	FLIXBOROUGH ENTERPRISE BH 2	485900	414700	2.2	Peat
SE81SE220	FLIXBOROUGH ENTERPRISE BH 3	485900	414700	3.3	Peat
SE81SE223	FLIXBOROUGH ENTERPRISE BH 6	485900	414700	2.8	Peat With Tree Trunks
SE81SE224	FLIXBOROUGH ENTERPRISE BH 7	485900	414700	5.3	Clay And Peat
SE81SE225	FLIXBOROUGH ENTERPRISE BH 8	485900	414700	4.8	Peat
SE81NW3	GARTHORPE WATER TOWER BH	483895	417774	0.8	Peat
SE80SW4	GAS COUNCIL PIPELINE SITE 2	484058	403257	1	Organic Peaty Clay
SE80SW5	GAS COUNCIL PIPELINE SITE 3	484095	403836	1	Organic Peaty Clay
SK79NE15	GYPSY LANE OWSTON FERRY	479300	397380	0.5	Black Peat With Reed Remains
SJ84SE99	HANFORD TP7	386480	342130	0.25	Organic Clay With Plant Remains
SJ84SE100	HANFORD TP8	386460	342040	0.3	Silty Organic Clay With Plant Remains
SE81NW26	HIGH BRIDGE FARM LUDDINGTON	482480	415260	0.8	Peat
SE81SE215	JETTY AT FLIXBOROUGH STATHER 2	485880	414500	3	Peat
SE81SE216	JETTY AT FLIXBOROUGH STATHER 3	485920	414460	2	Peat
SE81SE217	JETTY AT FLIXBOROUGH STATHER 4	485940	414480	4.57	Peat
SE81SE76	KEADBY SCUNTHORPE A 132KV LINE 48	487170	413250	0.15	Peat
SE81SE77	KEADBY SCUNTHORPE A 132KV LINE 49	486880	413080	1.6	Peat With Clay And Wood Traces
SE81SE78	KEADBY SCUNTHORPE A 132KV LINE 50	486630	412930	1.9	Peat
SE81SE79	KEADBY SCUNTHORPE A 132KV LINE 53	485790	412460	4.26	Peat
SE81SE80	KEADBY SCUNTHORPE A 132KV LINE 55	485240	412360	2.9	Peat
SE81SW70	KEADBY SCUNTHORPE A 132KV LINE 56	484920	412300	6.7	Peat And Silty Peat
SE81SW73	KEADBY SCUNTHORPE A 132KV LINE 60	483700	412400	2.4	Peat
SE81SW74	KEADBY SCUNTHORPE A 132KV LINE 61	483400	412440	2.1	Peat
SE81SW75	KEADBY SCUNTHORPE A 132KV LINE 62	483120	412260	1.21	Peat
SE81SW76	KEADBY SCUNTHORPE A 132KV LINE 63	482930	412130	0.75	Peat
SE81SW77	KEADBY WHARK BH1	483440	411400	0.3	Peat
SE81SW78	KEADBY WHARK BH2	483540	411370	1.1	Peat
SE81SW79	KEADBY WHARK BH3	483530	411390	2.2	Peat
SE81SW80	KEADBY WHARK BHA	483360	411420	2.5	Peat
SE81SW81	KEADBY WHARK BHB	483220	411410	1.4	Peat
SK42NE329	KEGWORTH DEEP LOCK BH 1	449210	326800	1.1	Organic Silty Clay
SK42NE330	KEGWORTH DEEP LOCK BH 2	449240	326790	0.6	Organic Clay With Shell Fragmenst
SK42NE331	KEGWORTH DEEP LOCK BH 3	449190	326780	0.6	Organic Sandy Clayey Silt And Peat
SE80SW22	KELFIELD	482027	401227	5.2	Peaty Silt
SE80SW18	KELFIELD GRANGE	481881	402211	7	Peat
SK11NE16	LODGE DEVELOPMENT BH 3	415980	316880	0.75	Silty Organic Clay + Reed Fragments

BGS Reference	Borehole Name	NGRE	NGRN	Thickness	Description
SK32NE105	M42 CASTLE DONINGTON SECTION B23	438410	328160	0.5	Clayey Peat
SJ84NE1951	MANORFIELDS LINK RD BH 2	388240	345220	2	Organic Silty Clay And Sand
SJ92NW26	MESSRS CHANCE & HUNT	392660	325240	2.13	Peat
SK22SW245	MOOR MILL DAM BH4	424960	323740	0.7	Peat
SE81SE152	MOORS ROAD SCUNTHORPE TH1	486910	410950	0.2	Peat
SE81SE161	MOORS ROAD SCUNTHORPE TH10	486930	410920	0.05	Peat
SE81SE153	MOORS ROAD SCUNTHORPE TH2	486910	410940	0.1	Peat
SE81SE154	MOORS ROAD SCUNTHORPE TH3	486930	410940	0.1	Peat
SE81SE155	MOORS ROAD SCUNTHORPE TH4	486950	410940	0.05	Peat
SE81SE157	MOORS ROAD SCUNTHORPE TH6	486940	410920	0.05	Peat
SE81SE158	MOORS ROAD SCUNTHORPE TH7	486940	410900	0.05	Peat
SE81SE159	MOORS ROAD SCUNTHORPE TH8	486920	410910	0.3	Peat
SE81SE160	MOORS ROAD SCUNTHORPE TH9	486910	410920	0.25	Peat
SE80SW16	NORTH EUSTER	483127	403043	7.6	Peaty Silt
	NORTH SOAK DRAIN BH 16	482420	411800	0.62	Peat
SE81SW2/J	NORTH SOAK DRAIN BH 2	483520	411630	1.6	Silty Peat
SE81SW2/K	NORTH SOAK DRAIN BH 3	483660	412260	1	Peat
SE81SW2/C	NORTH SOAK DRAIN BH 4	482380	411600	9.6	Peat
SE81SW2/A	NORTH SOAK DRAIN BH1	481050	411390	0.9	Peat
SJ95SW135	NORTON GREEN STOKE BH 13	390170	351950	2	Peat
SE80SW25	OWSTON FERRY	481699	400505	6.5	Silt With Fibrous Peat
SE81NW27	OX PASTURE LUDDINGTON	483700	415720	1.4	Peat
SE80SW8	POPLAR GROVEDRAIN	483990	404967	6.9	Peaty Silt And Fibrous Peat
SK22NE238	PRINCESS WAY TP 6	425000	325400	0.1	Peaty Clay
SK22NE246	PRINCESS WAY TP D	425000	325400	0.3	Organic Silty Clay
SK42NE327	PROP WEIR EXTENSION BH 4	449020	326720	0.7	Organic Clayey Silt With Wood And Shell
SJ92SW99	PSA STAFFORD BH 1-2	393850	324350	0.25	Organic Silty Clay
SK42NE343	RATCLIFFE LOOP & CUT BH 10	449130	329220	0.3	Peaty Silty Clay
SK42NE345	RATCLIFFE LOOP & CUT BH 12	448910	329390	0.5	Peaty Silty Sandy Clay
SK42NE335	RATCLIFFE LOOP & CUT BH 2	449360	329350	0.65	Clayey Silt With Rotting Vegetation
SK42NE338	RATCLIFFE LOOP & CUT BH 5	449180	329320	0.4	Organic Silty Clay
SK42NE51	RATCLIFFE LOOP & CUT R-ON-SOAR 12	448900	329410	0.5	Peaty Silty Sand Clay
SE80NW77	SCOTTER 58	482810	406560	6.1	Clay And Peat
SE81SE68	SCUNTHORPE PYLONS 10	485110	412270	0.3	Peat
SE81SE70	SCUNTHORPE PYLONS 12	485600	412350	0.1	Peat
SK22SW60	SEVERN TRENT 5	421600	322180	0.7	Peaty Silty Clay
SK22SW62	SEVERN TRENT 7	420280	320840	0.7	Peaty Silty Clay
SK89NW2	SNOW SEWER OUTFALL 1	481373	399457	2.06	Peat And Silty Clay
SK42NE119	SOAR VALLEY SAND AND GRAVEL	447804	329432	0.2	Black Silty Organic Clay
SE80SW7	SOUTH FIELD DRAIN	482058	404815	5.4	Peaty Silt
SE80SW11	SPECTACLE DRAIN	482886	404220	6.4	Peat And Silt
SJ92NW22	STAFFS C C NO 3	391780	325230	30	Peat
SK22SW259	STANTON WRW - RIVER TRENT BH26	424474	320966	1.65	Clayey Peat
SK21NE132	STANTON WRW TO RIVER TRENT BH4	426276	319250	0.5	Silty Organic Clay
SK21NE134	STANTON WRW TO RIVER TRENT BH6	426162	319266	1.2	Silty Sandy Organic Clay
SK23SE744	STOKE-DERBY MOTORWAY M64 HILTON-CHELLASTON 26	426430	330930	2.3	Organic Silty Clay
SK23SE745	STOKE-DERBY MOTORWAY M64 HILTON-CHELLASTON 30	426510	330920	2.9	Organic Silty Clay With Peat
SK23SE710	STOKE-DERBY MOTORWAY M64 HILTON-CHELLASTON B27	426470	330940	1.4	Organic Silty Clay
SK23SE711	STOKE-DERBY MOTORWAY M64 HILTON-CHELLASTON B28	426470	330920	1.5	Organic Silty Clay
SK23SE712	STOKE-DERBY MOTORWAY M64 HILTON-CHELLASTON B29	426460	330900	1.5	Organic Silty Clay
SJ83NE116	STRONGFORD BRIDGE WIDENING A34 BH 15	387250	339190	1.52	Peaty Organic Silt
SK22SW77	TATENHILL, RANGEMORE & BARTON BH11	420630	322020	0.25	Peat
SK22SW54	TELEPHONE EXCHANGE BURTON ON TRENT	424830	322490	0.5	Peaty Silty Clay
SK32NE74	TRENT VIADUCT M64 BH130	439340	327350	-0.6	Black Silty Organic Clay
SK32NE75	TRENT VIADUCT M64 BH131	439310	327340	0.3	Black Silty Organic Clay
SK32NE83	TRENT VIADUCT M64 BH145	439440	327150	0.4	Grey Organic Silty Clay
SK32NE84	TRENT VIADUCT M64 BH146	439420	327150	0.46	Organic Clay
SJ84NE1944	VICTORIA RD STOKE BH 13	388816	345854	5	Clayey Peat And Organic Clay
SJ84NE1945	VICTORIA RD STOKE BH 14	388842	345858	4.2	Organic Silty Clay
SE80SE62	WARP FARM	485181	403384	3.1	Silty Peat
SE80NW23	WEST BUTTERWICK	482570	405890	7	Peaty Silt
SE80NW27	WEST BUTTERWICK	483320	405100	1.6	Silty Peat
SE80NW19	WEST BUTTERWICK	482960	406800	6.9	Peaty Silt
SE80NW48	WEST BUTTERWICK HMB 18	482880	407440	9	Organic Silts And Clays: Peat
SE80SE56	WEST COMMON NORTH DRAIN	486263	404963	1.6	Peat
SK79SE15	WILLOW BANK LANE WALKERITH	479112	393625	2.8	Peat Woody

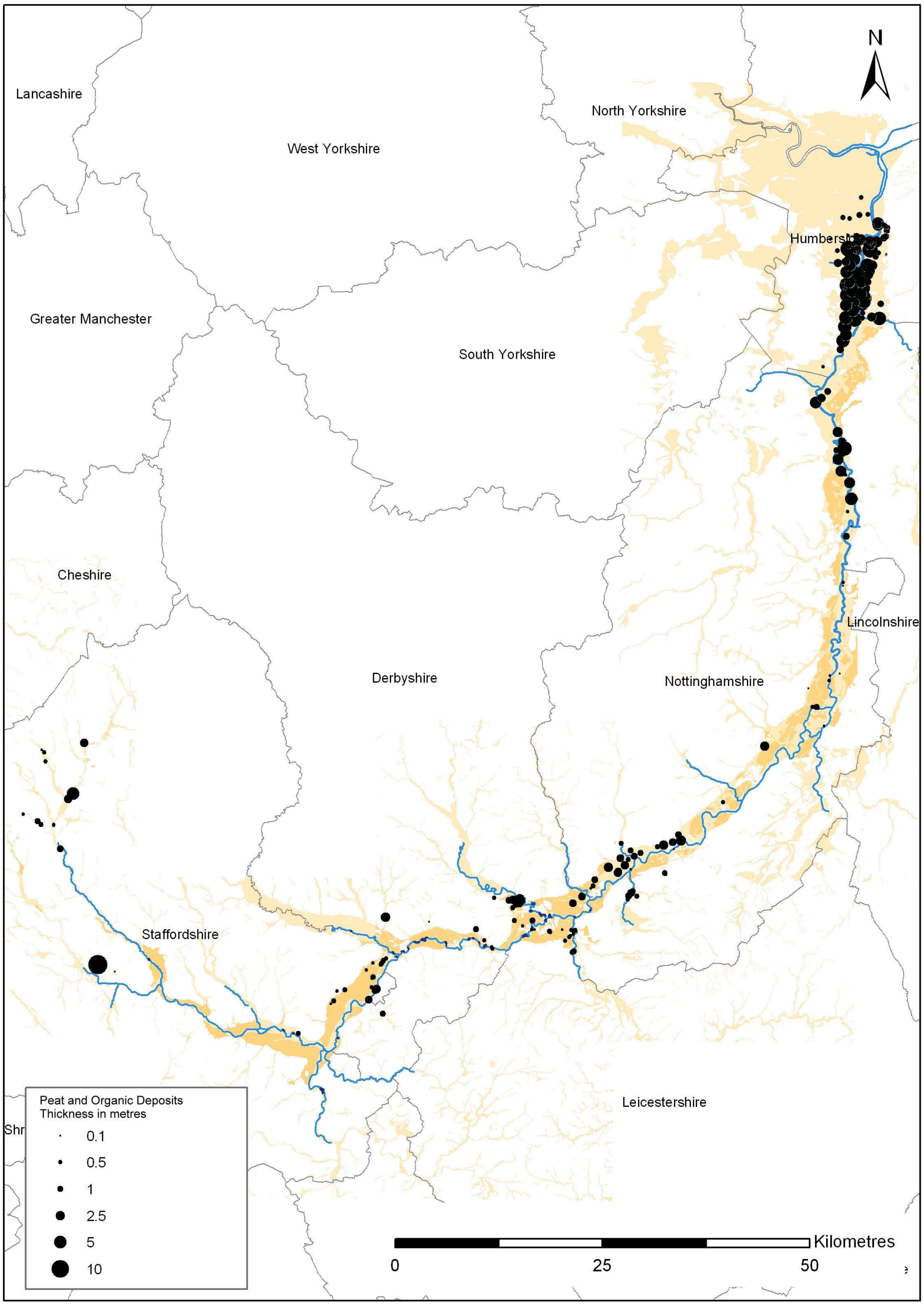


Figure 3. Map showing the extent of the floodplain and lower terraces of the Trent and the locations and thickness of all borehole records of peat and other organic sediments (including those examined as part of the 2001 study for Nottinghamshire County Council).

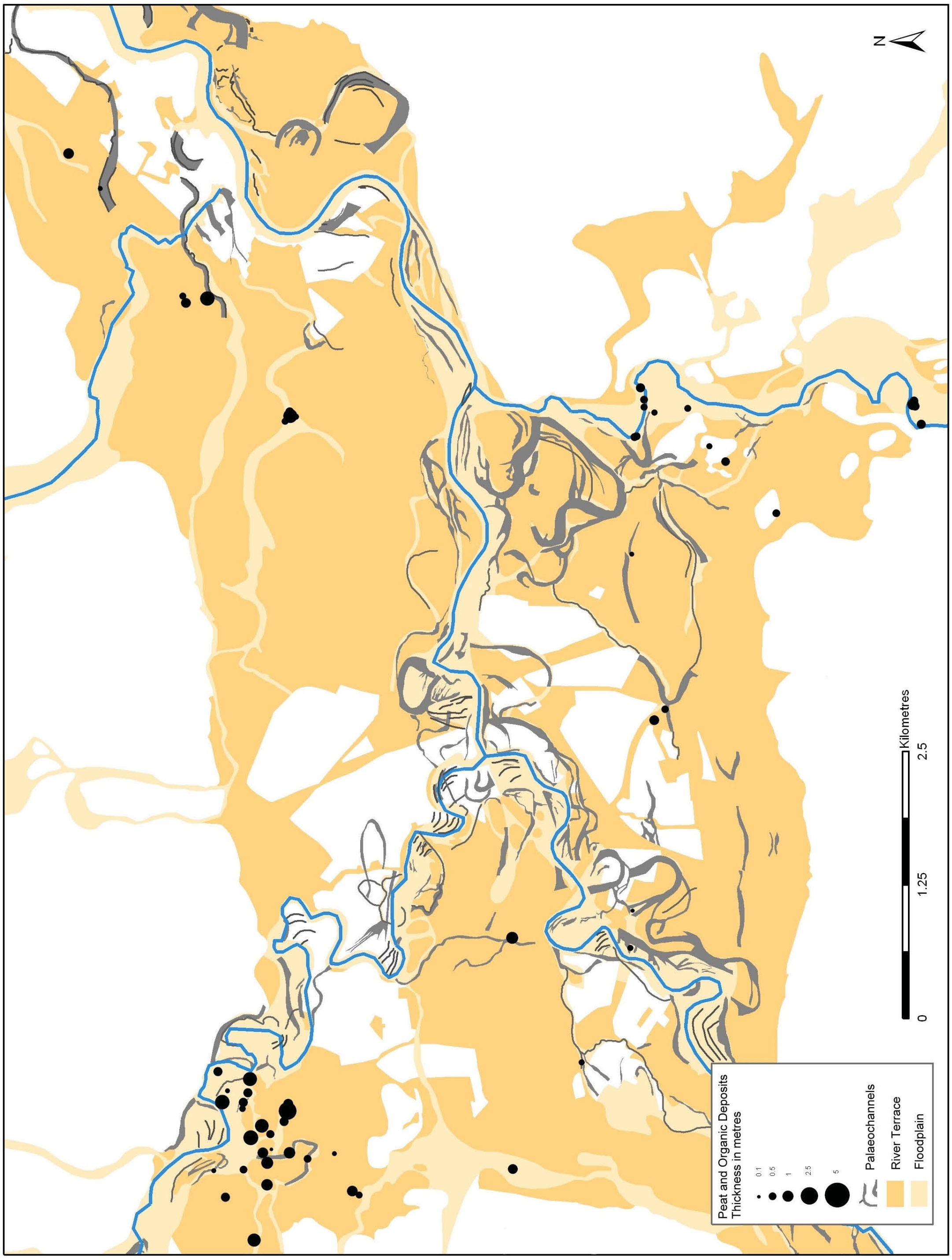


Figure 4. Borehole data in use in combination with other geoarchaeological data developed or acquired for Trent Valley GeoArchaeology 2002 including geological mapping from British Geological Survey and palaeochannel plots produced by Steve Baker at Trent & Peak Archaeological Unit. The borehole data has been displayed to show proportional circles indicating the locations and thickness of peat deposits.

3 A TECHNIQUE FOR MODELLING BOREHOLE DATA

3.1 Introduction

A method for modelling borehole data was developed as part of the Nottinghamshire study undertaken in 2001 and is fully reported therein (Challis 2001) and summarised in Challis and Howard 2003. The following text provides a brief review of the method used to produce the three-dimensional sub-surface DEM discussed and illustrated in section 4.

3.2 Surface Modelling Methods

As well as providing location specific data about the character of alluvial deposits, digitised borehole data represent a sample of the elevation values of floodplain palaeosurfaces from which continuous digital elevation models representing sub-surface floodplain topography may be produced by the application of an appropriate interpolation technique. The choice of an appropriate interpolation technique is fundamental to successful sub-surface modelling (Wiebel and Heller 1991). Different interpolation methods can produce profoundly different results from the same data and an inappropriate choice of interpolation function can compromise the accuracy and reliability of subsequent interpretation (Mitas and Mitasova 1999). The fundamental choice in modelling methods is between triangulation-based solutions, where elevation at sample points form the vertices of a network of articulated triangles, and grid-based solutions where a regular grid with values at the centre of each grid cell or at the nodes of the grid lattice is generated from the sample points by use of an appropriate interpolation function (Petrie 1990; Hutchinson and Gallant 1999). Triangulation-based solutions may be constrained to represent terrain structures such as ridges and stream lines and so their application is particularly appropriate where sample data have been recorded to identify such topographic features. Conversely geological surfaces, where data are collected without reference to the unseen sub-surface topography, may be more effectively modelled by a grid-based interpolation algorithm (McCullagh 1988), in particular one that will cope effectively with sparse, irregularly spaced data and produce a smoothed model of sub-surface topography.

Extensive trials modelling borehole records for the Nottinghamshire Trent using numerous and varied data have shown that the kriging interpolator is the most effective for modelling borehole data (Challis and Howard 2003; Challis 2001). Kriging, a geostatistical matrix based algorithm, interpolates a smoothed best-fit surface from observations and is widely used in geology and the earth sciences (Oliver and Webster 1990). The interpolation function is based on the solution of series of parallel equations modelling the relationship between each grid node, the sample points used in its interpolation, and the interaction between the sample values used for each interpolation. These equations can be controlled to express the spatial characteristics and trends of the sample data where these are known. In particular this allows kriging to model trends between samples so that, for example, high points might be modelled as connected along a ridge, rather than isolated as peaks. Kriging is a perfect interpolator in that, given a suitable grid resolution, sample values are faithfully retained in the interpolated surface.

3.3 Identifying Error in the Sample Data

It is important to identify errors introduced by sample data of questionable reliability at the outset of the modelling process. This issue is particularly important as some boreholes logs lacked OD values for the top, which had therefore to be estimated from a surface DEM of the floodplain generated from Ordnance Survey Panorama 10m contour data. This use of Panorama data poses considerable problems, not least that the 10m contour interval, even with additional form lines, is not ideal for modelling the subtleties of floodplain topography. Furthermore, DEM generated from Panorama data have been shown to exhibit a range of inaccuracies which are the product of the sample bias introduced by the contour interval (Wood 1996). OD values for borehole observation calculated using the surface DEM must therefore be treated with caution and regarded as less reliable than OD values recorded in the field

Identification of the errors in the sample data was achieved by the critical inspection of computer rendered visualisations of each surface before any further analysis. This is most readily achieved using a shaded relief or image map (Figure 5; where grey tone represents elevation) a technique recommended by Hutchinson and Gallant (1999). Areas where features in the rendered surface are weakly spatially correlated with the area around (for example significant spikes or pits in the DEM) show as high contrast black or white allowing the original data to be checked and an assessment made of its reliability. Sample data considered unreliable were discarded and the surface recalculated, rendered and reassessed. This process also served as an effective check on errors introduced by inaccuracies in digitising for example incorrectly entered values for depth or thickness of the stratigraphic horizons modelled.

3.4 The Impact of Grid Resolution

The choice of interpolated grid resolution is highly significant. McCullagh (1998) points out that if all original observed values are to be used in the interpolation process the spacing of the nodes within the interpolated surface must be no greater than half the distance between the closest spaced observations. Where data are small and sample points uniformly spaced this presents few problems, however, since storage and computation overheads increase significantly as grid cell size becomes smaller the decision to increase grid resolution cannot be taken lightly with a large quantity of data.

Grid resolution is particularly important as a number of studies have shown that variations can have a significant impact on the accuracy and reliability of data, such as maps of slope and aspect, derived from the DEM. Gao (1997 and 1998) showed that calculations of slope gradient are significantly affected as DEM resolution decreases, particularly in areas of gently rolling terrain, while measurements of aspect are less affected. This is significant for the present study as measurements of slope gradient derived from the sub-surface DEM provide one method of rapidly identifying buried palaeochannels by highlighting their sloping sides.

The impact of variations in grid resolution is shown in Figure 6, which shows the results of interpolated grid resolutions of 200, 100 and 50m on the same data. Following Gao 1998, frequency histograms were prepared of slope gradient at each DEM resolution; examination suggests that the lower grid resolution fails to model

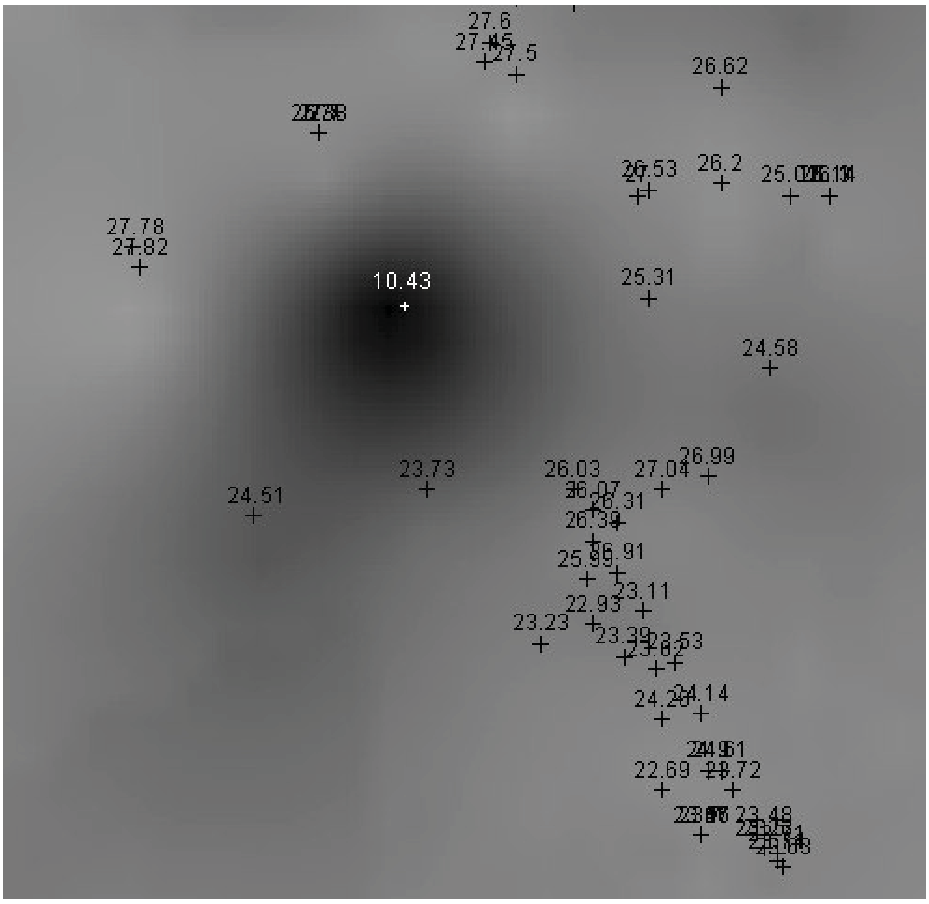


Figure 5. Visual assessment of DEM data error. Enlargement of part of a greyscale plot of an interpolated surface showing a weakly spatially correlated feature as a dark area. Superimposed are the OD values assigned to the top of borehole observations used in the interpolation of the surface. An error in surface elevation for one sample value (of *c*. 10m as compared to *c*.25m for surrounding sample points) can be identified as the cause of this DEM error. (From Challis 2001 figure 8).

areas of steeper slope, which only appear in the 50m resolution DEM. These areas of steeper slope are significant as they may indicate the edges of palaeochannels or palaeochannel belts. The failure of the 200m, and to a lesser extent 100m, resolution DEM to model the steepest slopes probably arises as they are not able to incorporate closely spaced sample values in the interpolation and it is these closely spaces samples that are most likely to reveal sub-surface topography.

3.5 GIS-based analysis of DEM

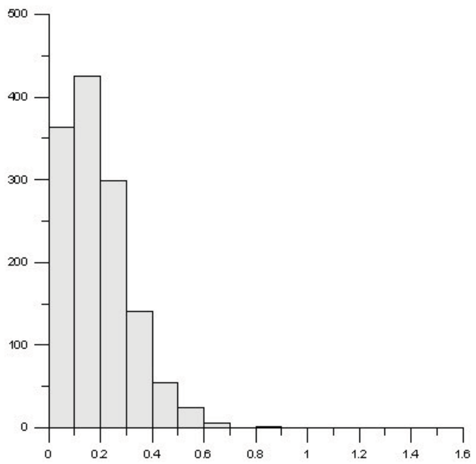
McCullagh (1998) rightly asserts that terrain models require good visualisation for effective use in geomorphological applications. In the Trent Valley surface modelling has been carried out using Golden Software's Surfer8 surface modelling package, which offers access to a wide variety of interpolation algorithms and a high degree of control over the application of the chosen algorithm to sample data. All DEM have been integrated within a valley-wide geographical information system developed over a number of years using ESRI's ArcGIS GIS (Howard, Challis & Macklin 2001). ArcGIS allows interactive computer rendering of the surface DEM in 3D space. In fact, ArcGIS 3D Analyst is a 2.5D GIS (as defined by Raper and Kelk 1991) in that it projects z co-ordinates for x,y,z triplets to create a surface with no thickness visualised in 3D space, rather than creating true irregular 3D solids, in which multiple z values may exist at the same x,y location. However, ArcGIS does allow the stratigraphically correct integration of successive surfaces representing different geological units and the addition of point observations, such as the locations of borehole records of peat, allowing peat location and thickness to be visualised stratigraphically within the overall DEM. Source data, such as the georeferenced borehole logs may be draped over the DEM for interrogation and display and additional surfaces, for example representing the present floodplain, and data such as locations of cultural archaeological features, may be correctly positioned, viewed and interrogated within 3D space.

3.6 Commentary on DEM Generation TVG 2002

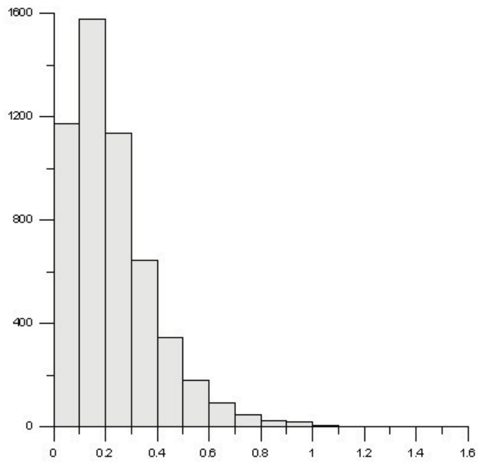
In the present study sub-surface DEM have been produced for three reaches (1 The Lower Trent to the Humber Estuary, 3 The Trent Derwent Confluence and 4 The Dove Tame Confluence) where borehole data were judged to be sufficiently frequent so as to produce viable models of the sub-surface.

DEM were produced for the basal topography of unit 1 (silt and clay alluvium – usually coincident with the top of sand and gravel), basal topography of unit 2 (sand and gravel – usually coincident with the top of bedrock or earlier glacial or glaciolacustrine drift) and top of unit 3 (bedrock). All DEM were produce at a 50m grid resolution to Ordnance Datum.

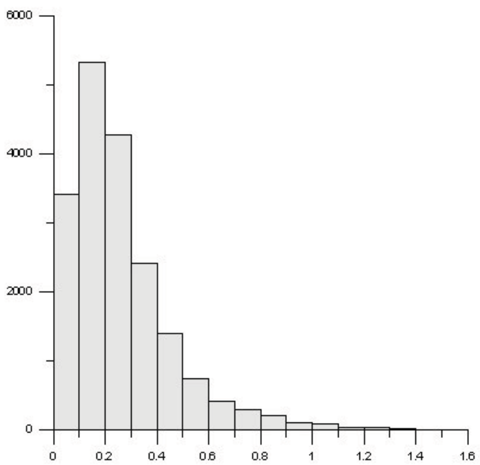
The calculation of Ordnance Datum levels for the DEM has proven problematic. It had been anticipated that this information might be gained from LiDAR elevation data, however, in the event these data were not available for the areas modelled. Thus in reaches 1 and 4 OD values for the tops of boreholes were abstracted from a surface DEM generated from Ordnance Survey 10m Panorama contours. This is a poor solution, as 10m contour data poorly reflect floodplain topography (Figure 7). As a consequence the OD values given on the sub-surface DEM and profiles for reaches 1 and 4 should be treated as unreliable. In reach 3 borehole logs included OD values at the top of each borehole and these values were used in all calculations.



A: Histogram of slope gradient derived from 200m DEM



B: Histogram of slope gradient derived from 100m DEM



C: Histogram of slope gradient derived from 50m DEM

Figure 6. Histograms of slope gradient frequency derived from DEM at 200, 100 and 50m cell size generated using kriging. In each case the x axis is slope gradient measured in percentage and the y axis is frequency. (From Challis 2001, figure.18).

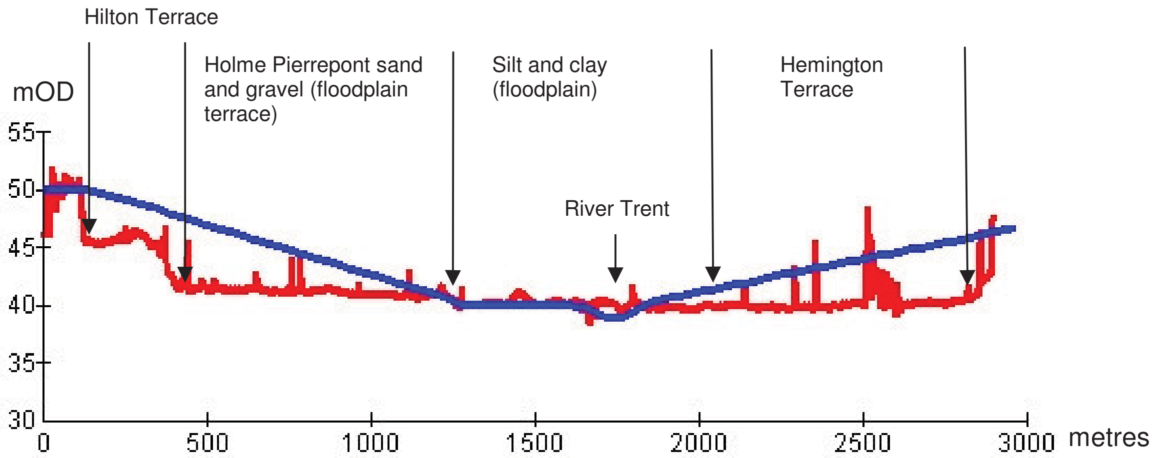


Figure 7. Cross valley profiles comparing LiDAR (red) and OS Panorama (blue) generated DEM of a sample section of the Trent Valley. It is evident that the OS data produces a highly generalised picture of actual terrain, whereas in the LiDAR data it is possible to identify individual landscape components. The spikes in the LiDAR data are caused by opaque and semi-opaque ground objects such as trees and buildings.

4 RESULTS

4.1 Study Reaches

For the purposes of data collection the Trent Valley was divided into six study reaches, each equating approximately to a naturally defined river reach, as follows:

Reach 1: From the Idle to the Humber
Reach 2: The Lower Trent Valley
Reach 3: The confluence of the Trent, Derwent and Soar
Reach 4: The Middle Trent Valley between the Dove and the Blithe
Reach 5: The Upper Trent Valley
Reach 6: The Headwaters of the Trent

Results for each study reach are discussed and illustrated below. GIS data are also presented in these six study reaches (see appendix 1 for details).

4.2 Reach 1: From the Idle to the Humber

This reach comprises the floodplain of the Trent from the confluence of the River Trent with the Humber Estuary at Trent Falls upstream as far south as the confluence of the Rivers Trent and Idle (Figure 8).

This reach may be characterised as a as a low-energy perimarine river system (Howard and Mackiln 1999). Alluvial deposits are dominated by vertical accretion and the formation of deeply stratified sequences of fine-grained sand, silt, clay and peat. There is a very high potential for preservation of organic material in palaeochannels and waterlogged depressions on former land surfaces but high levels of vertical accretion mean that these features are often not evident at the floodplain surface.

In all 331 borehole records were examined, providing a comprehensive record of alluvial stratigraphy. The general character of the river reach is demonstrated by the generally substantial thickness of fine-grained silt and clay alluvium (up to 19m thick) and the presence of extensive peat and organic silt deposits (recorded in 118 boreholes) suggesting both organic deposits accumulated in palaeochannels and blanket peat deposits sealed by later alluviation.

Table 3 Summary of borehole observations for Reach 1, from the Idle to the Humber.

	TVG 2002
Unit 1: Alluvium	208
Unit 2: Sand and Gravel	230
25ft drift	12
Organics	118
Unit 3: Rockhead	196
No Boreholes	331

4.2.1 *Three-Dimensional Sub-Surface DEM*

In total 208 borehole records in this reach provided a full picture of alluvial stratigraphy (ie included details of all stratigraphic units). Their relatively even distribution permitted the production of sub-surface digital elevation models for the base of fine-grained silty and clay alluvium (Figures 10 and 13) base of sand and gravel (Figures 11 and 14) and top of the bedrock (Figures 12 and 15) for the entire river reach.

The most striking feature of the DEM is the marked depression in both the sand and gravel and bedrock surfaces approximately following the present course of the Trent. This feature also shows clearly in the cross-valley profile generated from the DEM (Figure 16). In origin this feature may relate both to episodes of incision by the Trent during lower base levels and perhaps to increased discharge caused by glacial meltwater (*cf* Gaunt 1981).

The presence of peat deposits, in some cases in association with depressions in the sand and gravel surface adjacent to the present channel of the Trent, suggests the presence of palaeochannels of the Trent beyond those mapped from aerial photographs, and perhaps not readily visible at the present floodplain surface because of burial beneath later alluvial sediment.

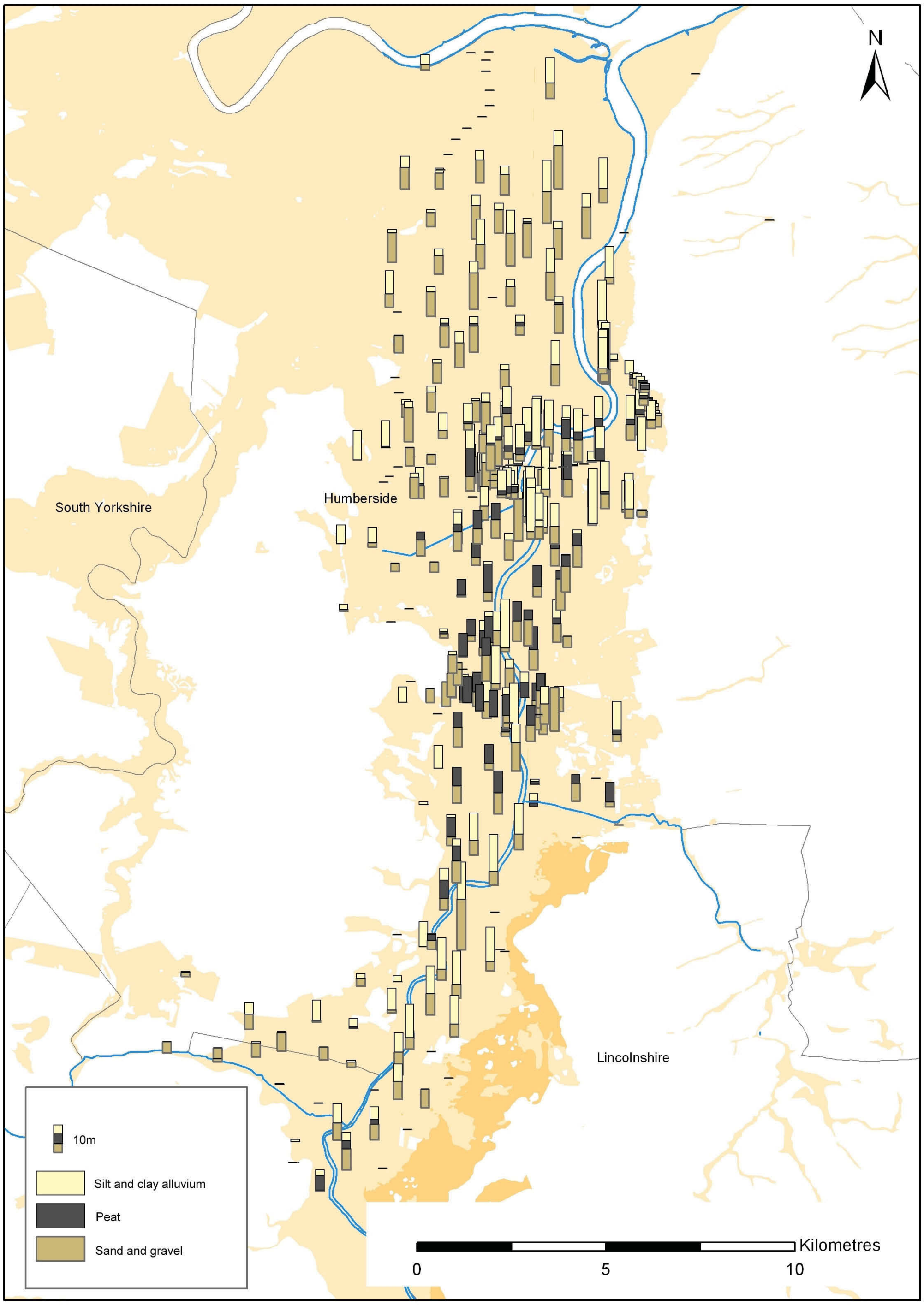


Figure 8. Map showing the extent of the floodplain younger terraces of the Trent and the locations of all borehole records examined as part of the Trent Valley GeoArchaeology study within Reach 1, from the River Idle to the Humber Estuary. Borehole data are shown as stacked bar charts indicating the locations and thickness of the principal stratigraphic units.

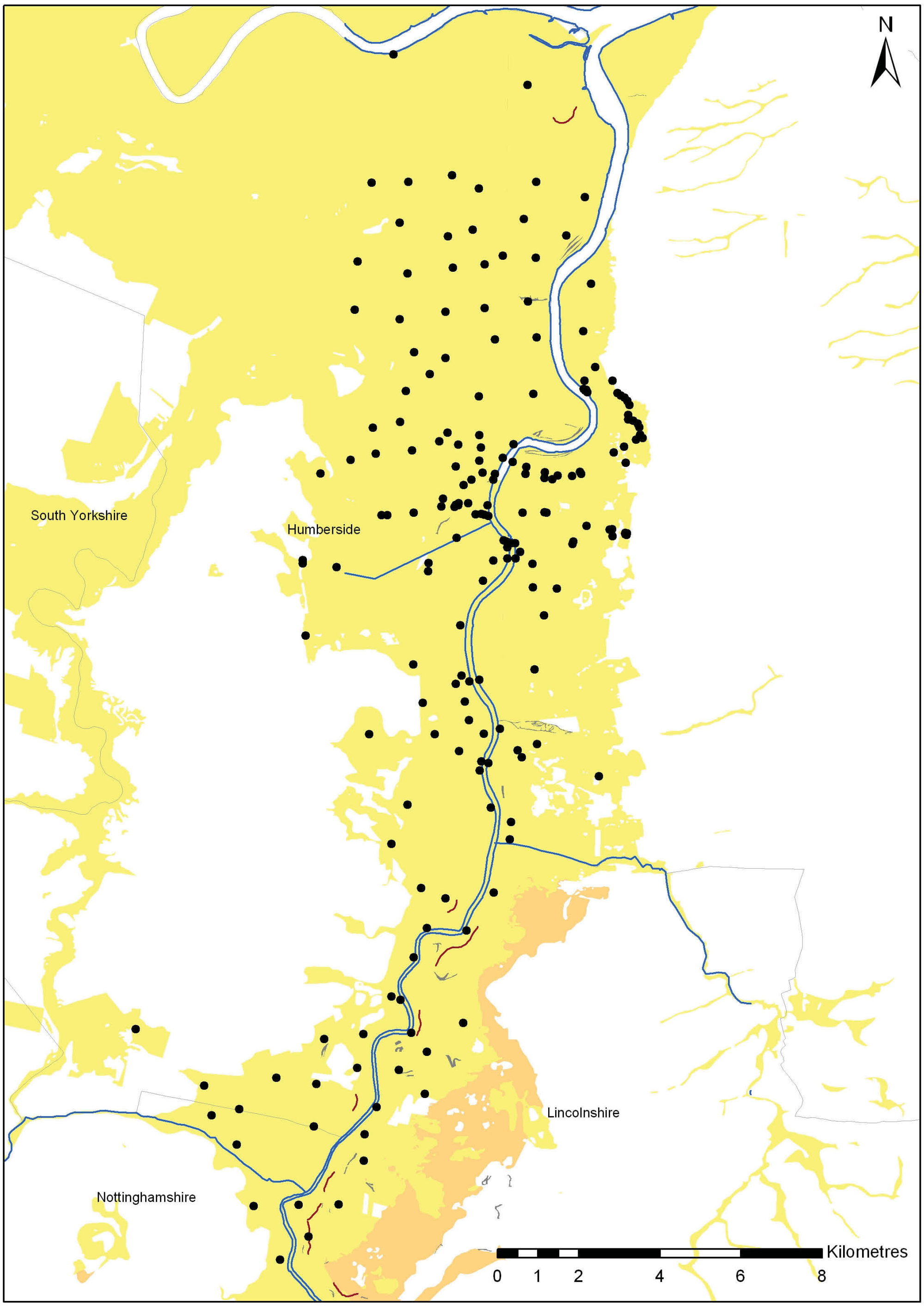


Figure 9. Map showing the extent of the floodplain and lower terraces of the Trent and the locations of all borehole records used for sub-surface DEM.

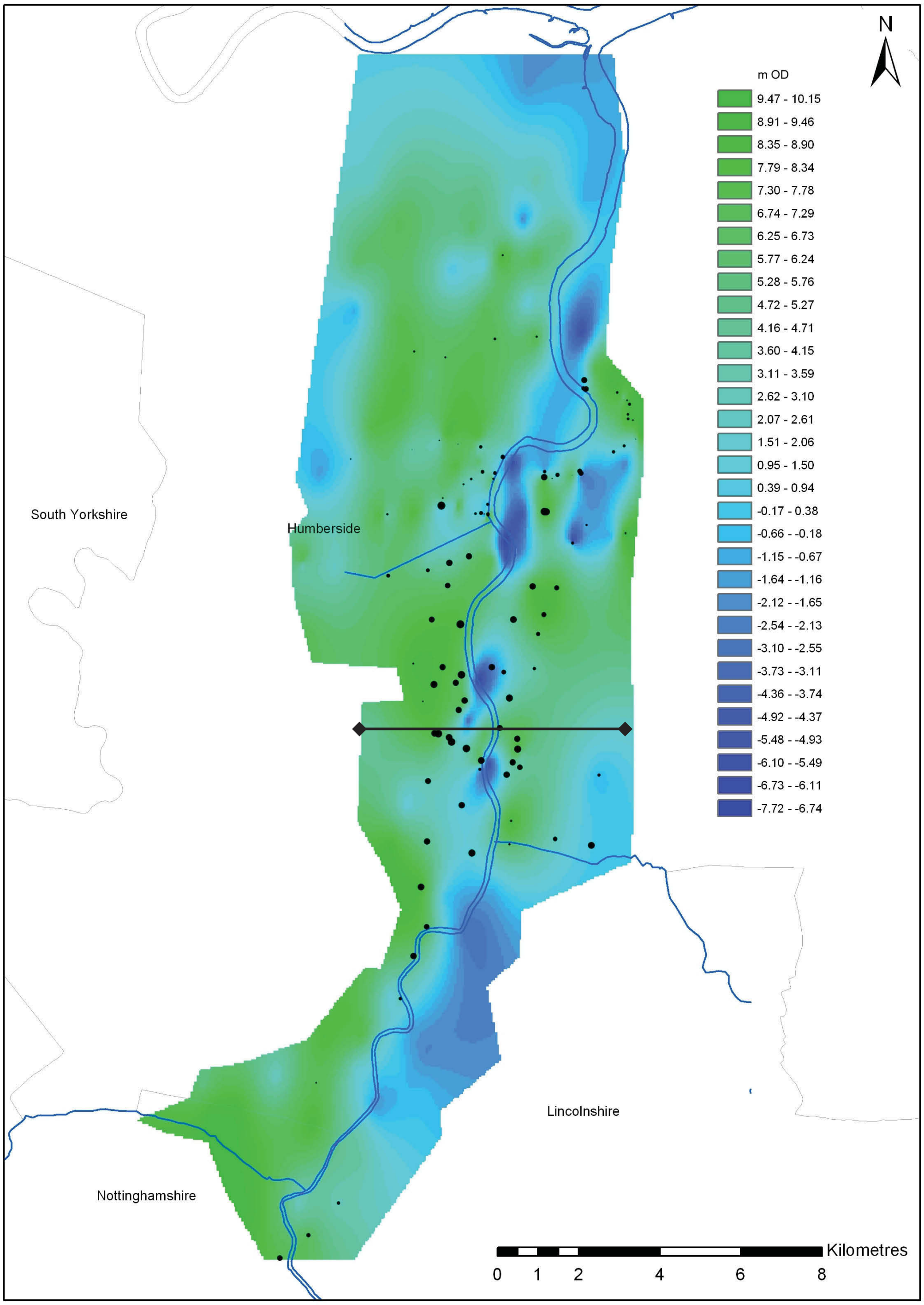


Figure 10. DEM of sub-surface topography at the base of fine-grained silt and clay alluvium. Black circles indicate locations and thickness of organic deposits. Line of profile in Figure 16 shown.

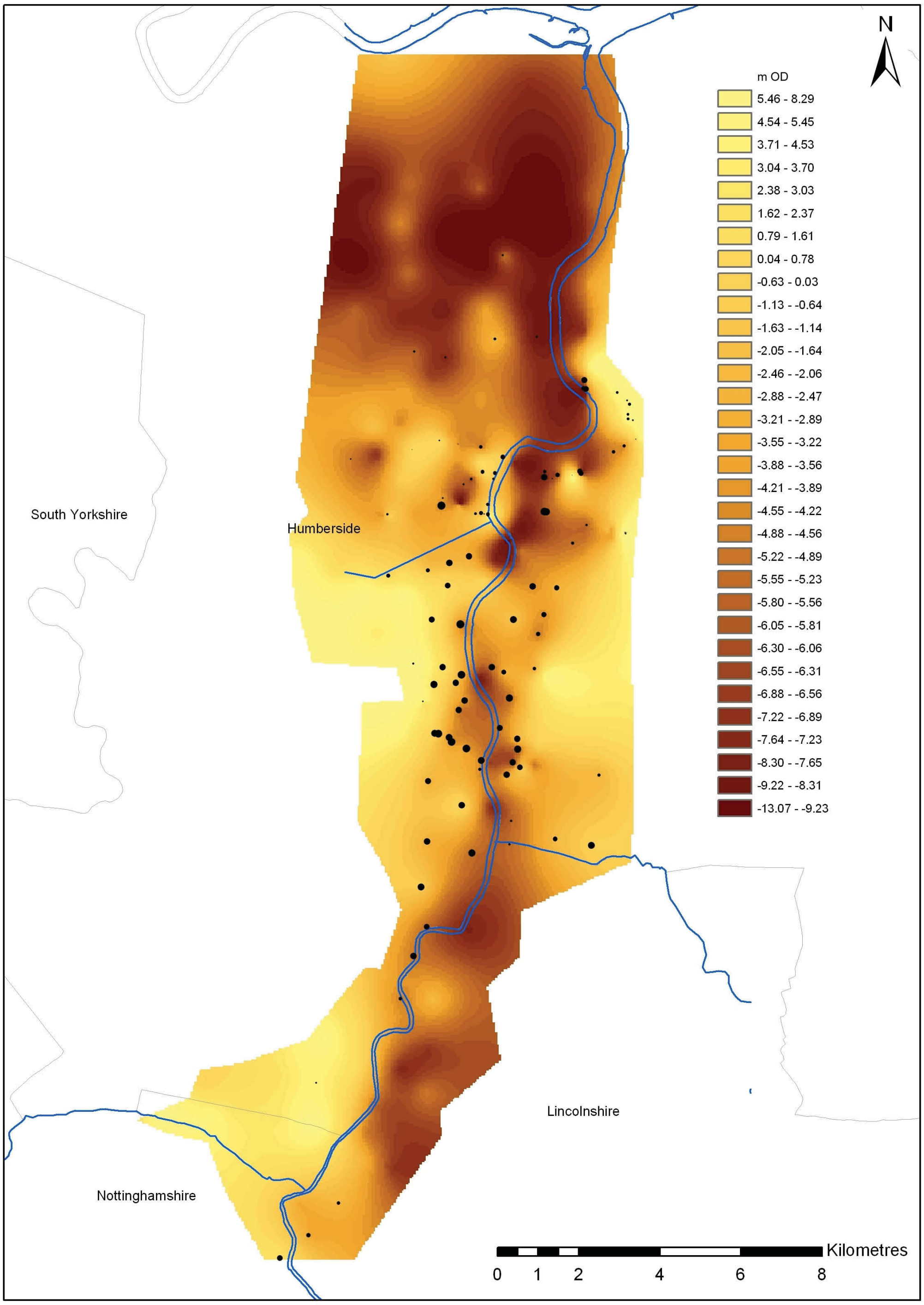


Figure 11. DEM of sub-surface topography at the base of sand and gravel. Black circles indicate locations and thickness of organic deposits.

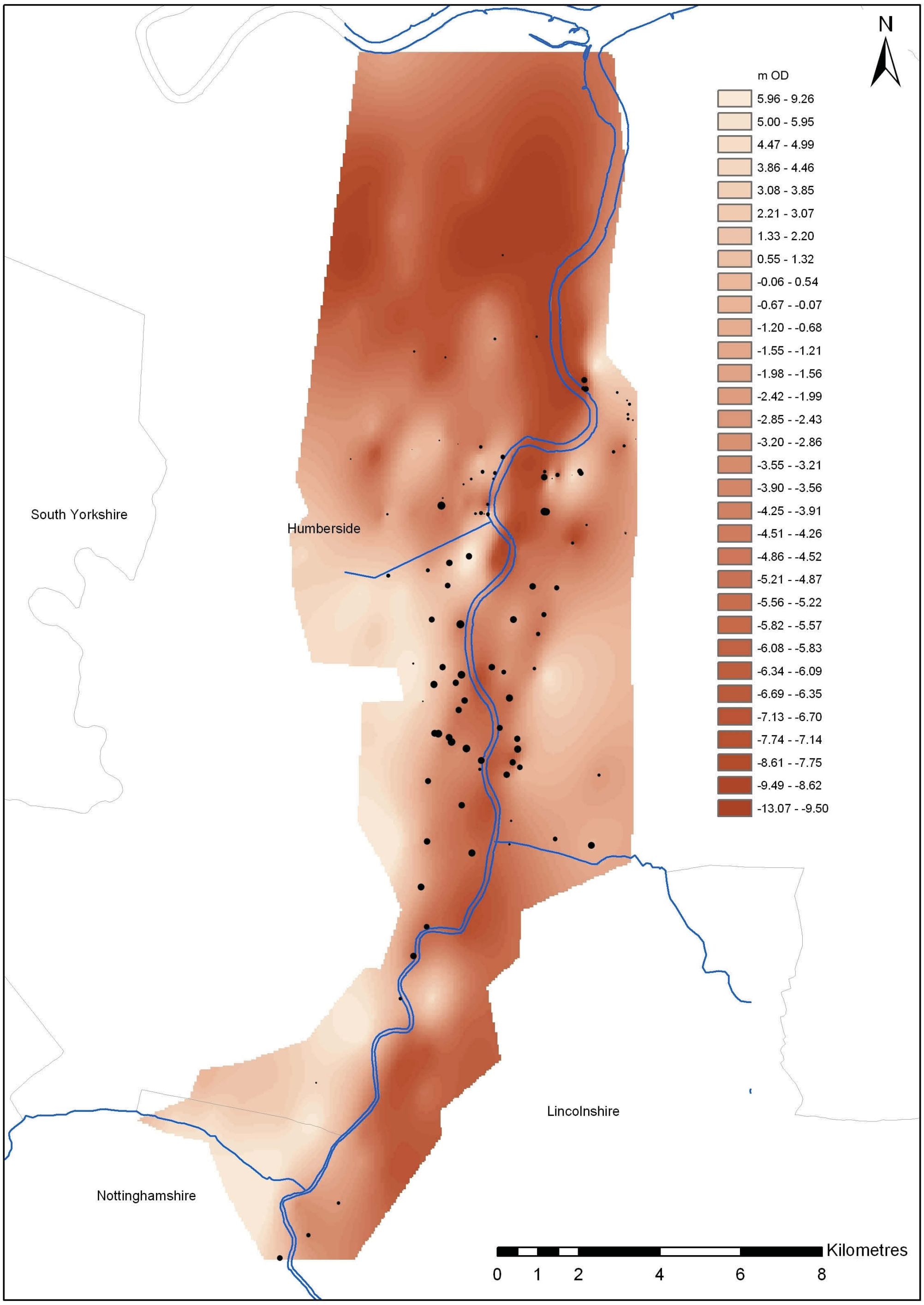


Figure 12. DEM of sub-surface topography at top of bedrock. Black circles indicate locations and thickness of organic deposits.

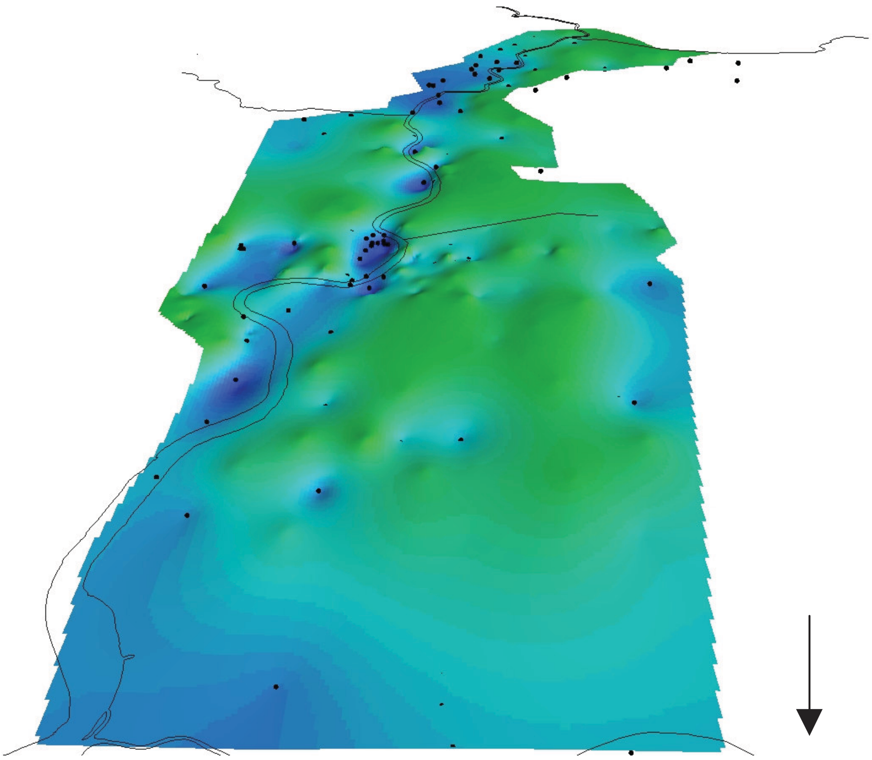


Figure 13. Three-dimensional view of DEM of the base of fine-grained silt and clay alluvium looking south from the Humber Estuary along the Trent Valley. Black circles indicate data points used to construct the model.

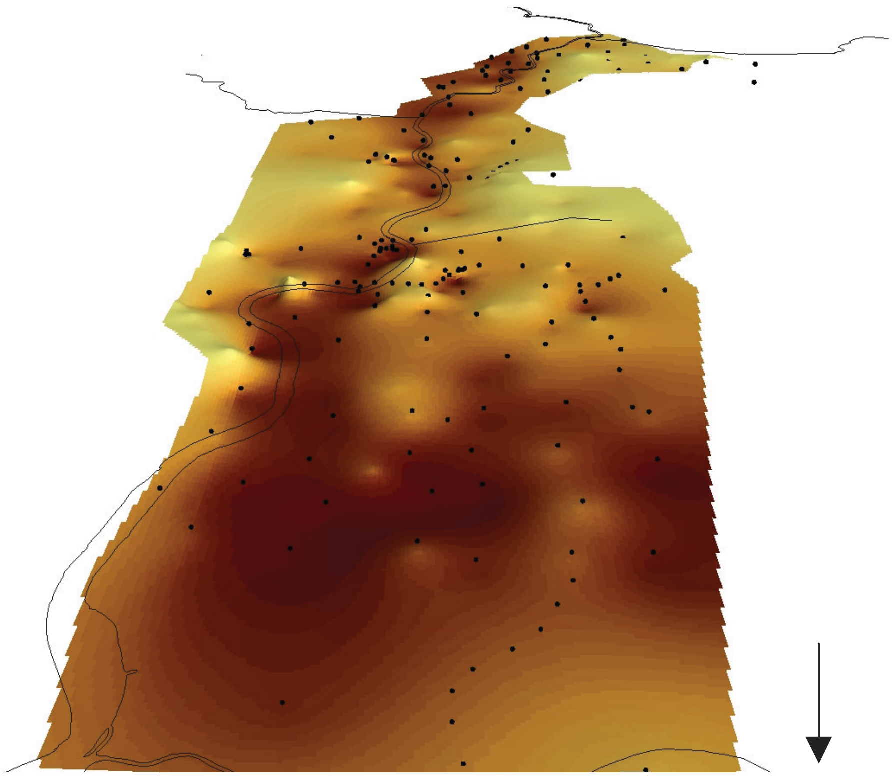


Figure 14. Three-dimensional view of DEM of the base of sand and gravel looking south from the Humber Estuary along the Trent Valley. Black circles indicate data points used to construct the model.

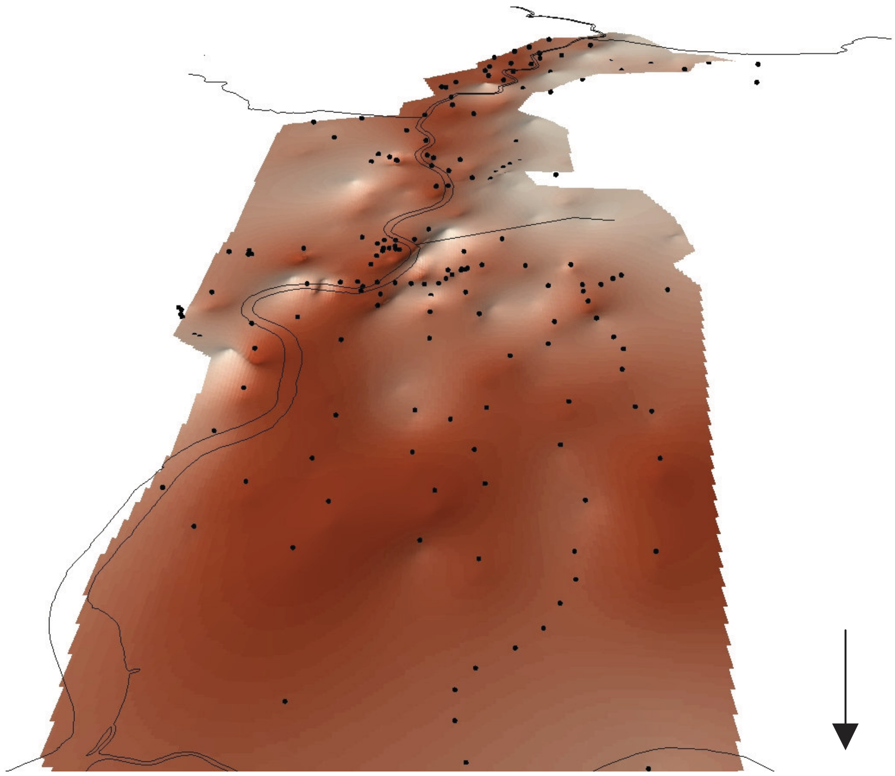


Figure 15. Three-dimensional view of DEM of top of bedrock looking south from the Humber Estuary along the Trent Valley. Black circles indicate data points used to construct the model.

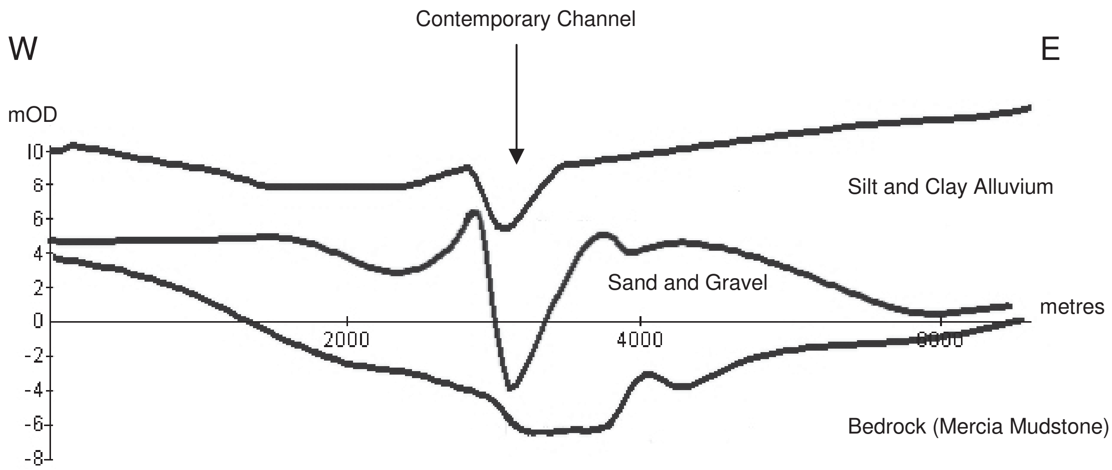


Figure 16. Profile through the alluvial deposits of the Lower Trent Valley as modelled by the sub-surface DEM. OD values are indicative only.

4.3 Reach 2: The Lower Trent Valley

The Lower Trent Valley was comprehensively examined as part of the 2001 Nottinghamshire study (Challis 2001). However, in the intervening period a number of previously confidential borehole logs have been released into the public domain. Opportunity was therefore taken to examine and digitise these to supplement the existing data. This data is summarised in table 4 and Figure 17. The alluvial stratigraphy of the Lower Trent Valley is discussed and illustrated in the earlier report (Challis 2001, 53-58).

Table 4 Summary of borehole observations for Reach 2, the Lower Trent Valley.

	TVG 2002
Unit 1: Alluvium	34
Unit 2: Sand and Gravel	32
Organics	2
Unit 3: Rockhead	34
No Boreholes	85

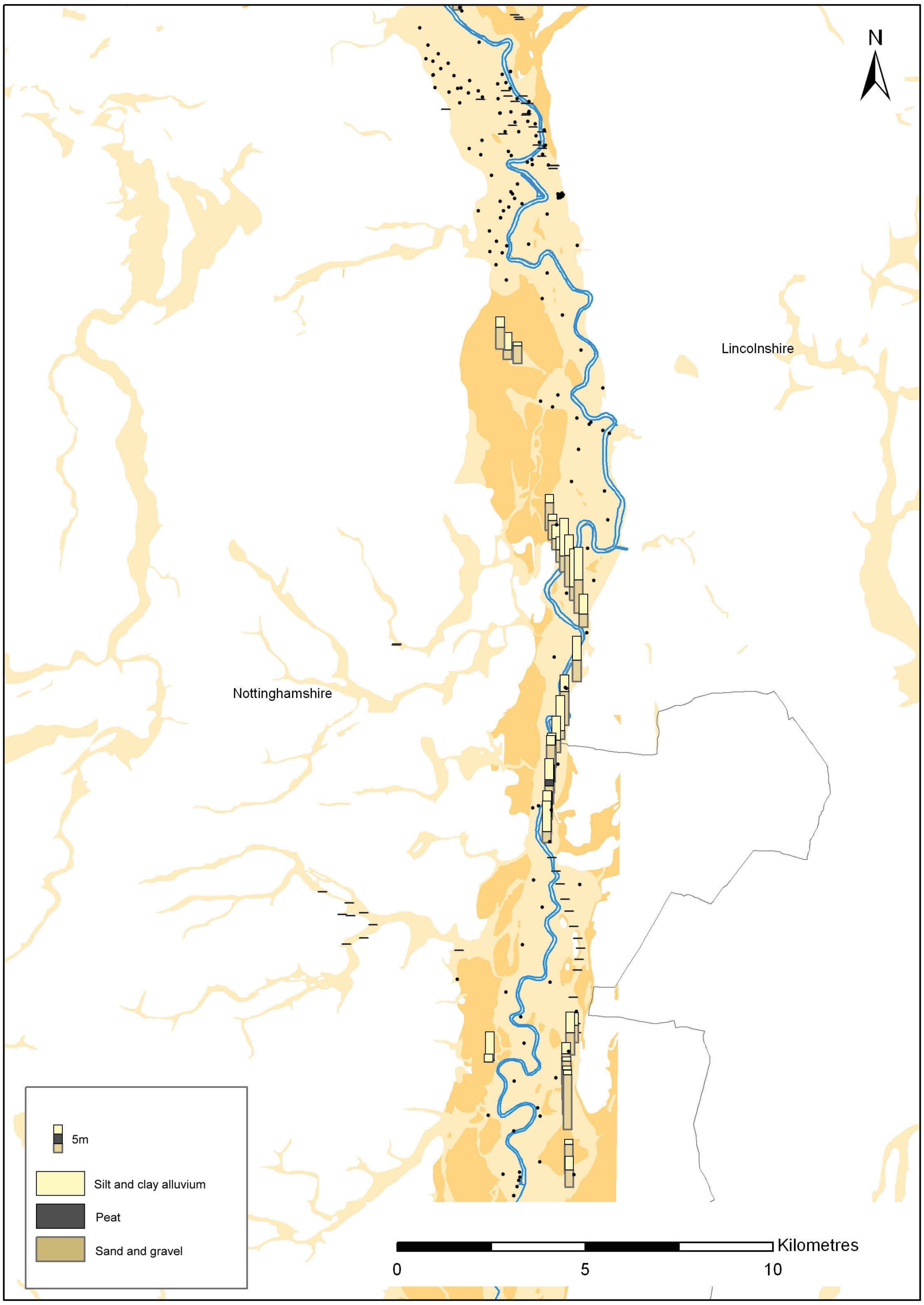


Figure 17. Map showing the extent of the floodplain and lower terraces of the Trent and the locations of all borehole records examined as part of the Trent Valley GeoArchaeology study within Reach 2, the Lower Trent Valley. Borehole data are shown as stacked bar charts indicating the locations and thickness of the principal stratigraphic units. Black dots indicate the locations of boreholes examined as part of the study of the Trent Valley undertaken for Nottinghamshire Count Council in 2001.

4.4 Reach 3: The Confluence of the Trent Derwent and Soar

This 20km reach comprises the Middle Trent Valley between its confluence with Rivers Derwent, Soar and Erewash upstream as far as the River Dove. A total of 1045 borehole records of this reach were examined (Table 5 and Figure 18), providing a comprehensive record of the alluvial stratigraphy. The distribution of the borehole records is not even and concentrations of records occur for the Elvaston Quarry in the Lower Derwent and for the line of the A50 Derby Southern Bypass across the Trent floodplain.

The complex drift geology of this reach has been recently investigated by British Geological Survey, and the resulting highly detailed mapping provided a useful complement to the borehole records. Alluvial stratigraphy in this confluence zone is notoriously complex (Brown *et al*. 2001; Brown 2002). In general, alluvial deposits in the floodplain are dominated by coarse grained sediments deposited in braided, anastomosing and meandering channels and fine grained accretion deposited during overbank flooding. Within the floodplain, organic remains may survive in palaeochannels and other waterlogged depressions on former land surfaces. The impact of medieval and later reworking of the valley floor gravels (for example at Hemington Quarry; Cooper 2003) is imperfectly understood but is likely to have had a considerable impact particularly in the eastern part of this reach.

Table 5 Summary of borehole observations for Reach 3, the confluence of the Trent Derwent and Soar.

	TVG 2002
Unit 1: Alluvium	446
Unit 2: Sand and Gravel	551
Organics	27
Unit 3: Rockhead	446
Total Boreholes	1045

4.4.1 Three-Dimensional Sub-Surface DEM

In total 146 borehole records for the Elvaston Quarry areas were used to produce sub-surface DEM for the base of fine-grained silty and clay alluvium (Figure 19B) base of sand and gravel (Figure 19C) and top of the till or bedrock (Figure 19D) of a section of the valley of the River Derwent close to its confluence with the Trent.

The Lower Derwent Valley was studied by Knight and Howard (1995) in their review of Archaeology and Alluvium in the Trent Valley and Figures 19 and 20 may be usefully compared to the profile across the Lower Derwent at Elvaston published therein (Knight and Howard 1995, fig 5.7).

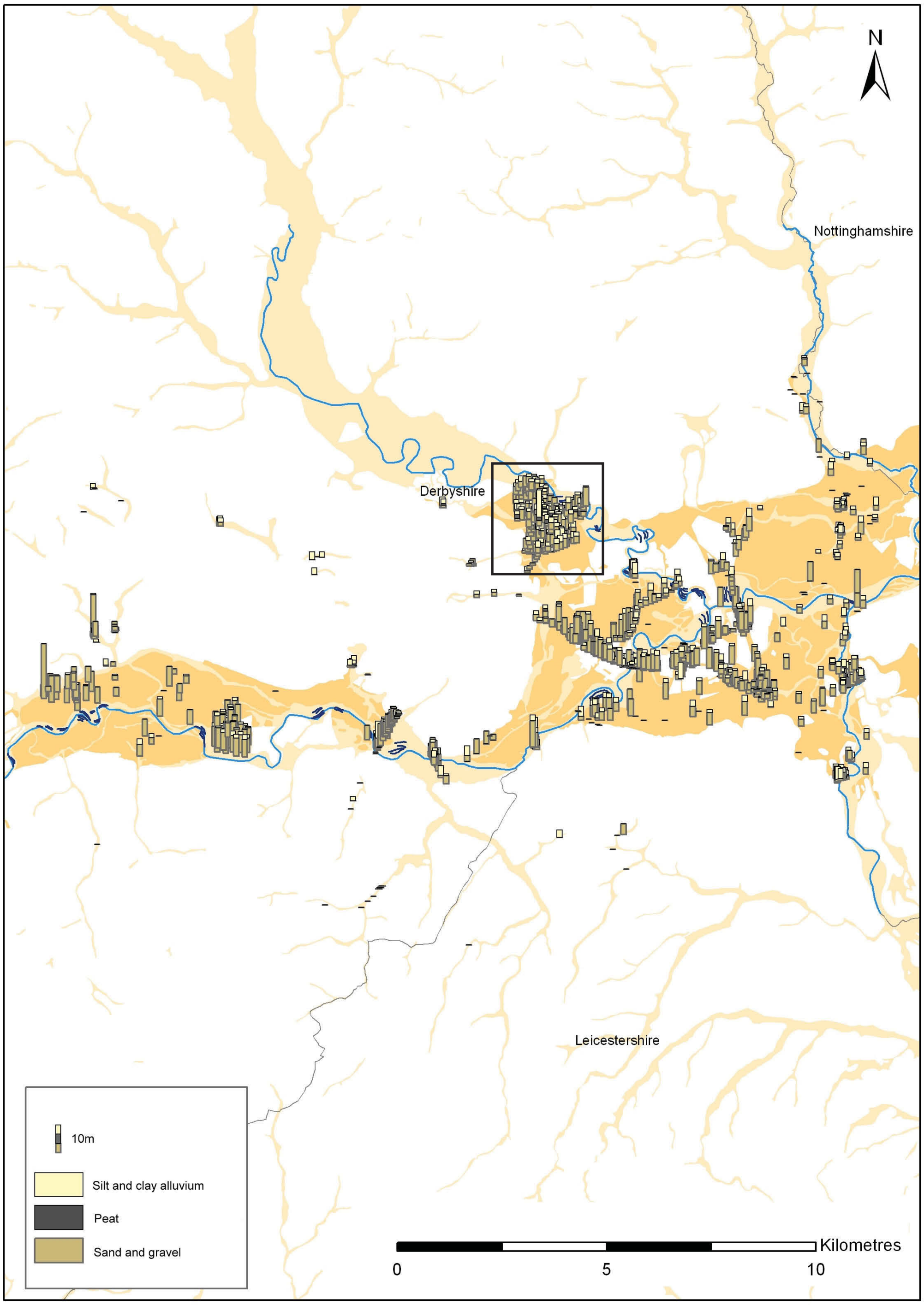
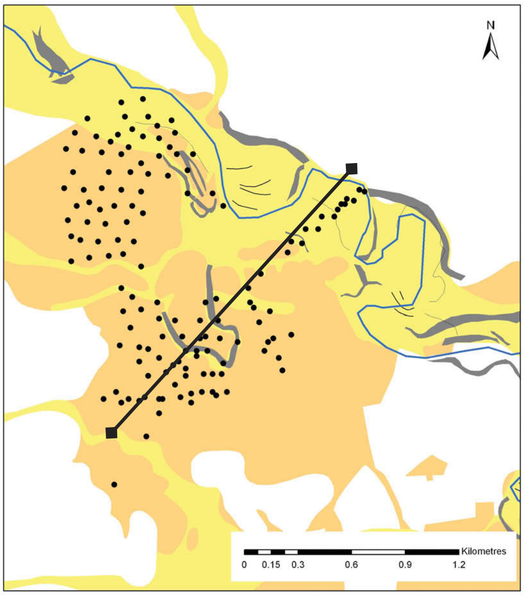
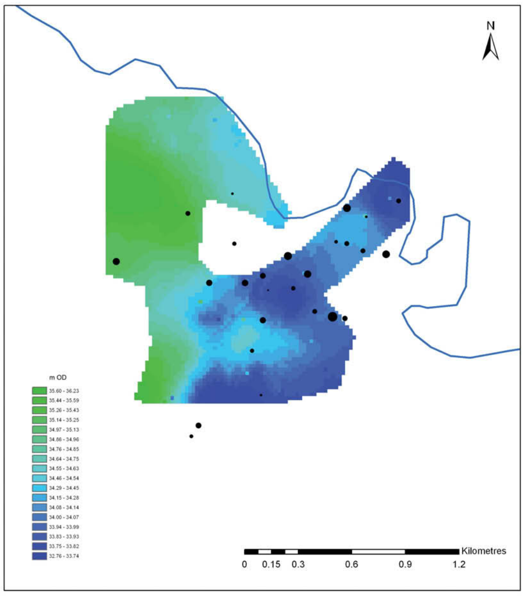


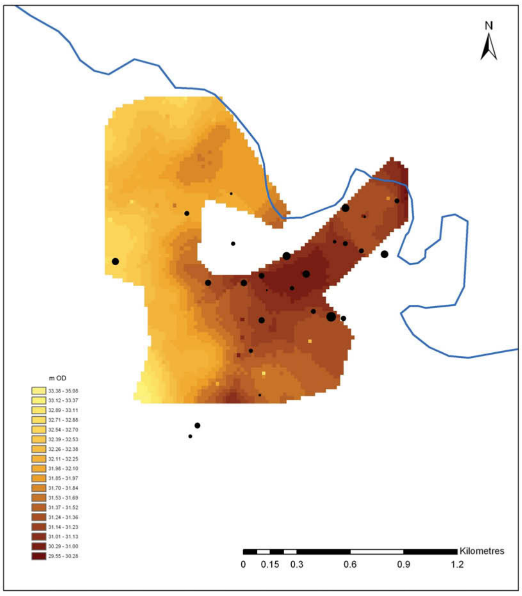
Figure 18. Map showing the extent of the floodplain and lower terraces of the Trent and the locations of all borehole records examined as part of the Trent Valley GeoArchaeology study within Reach 3, the confluence of the rivers Trent, Derwent and Soar. Borehole data are shown as stacked bar charts indicating the locations and thickness of the principal stratigraphic units. The area selected for three-dimensional sub-surface modelling is indicated by the black rectangle.



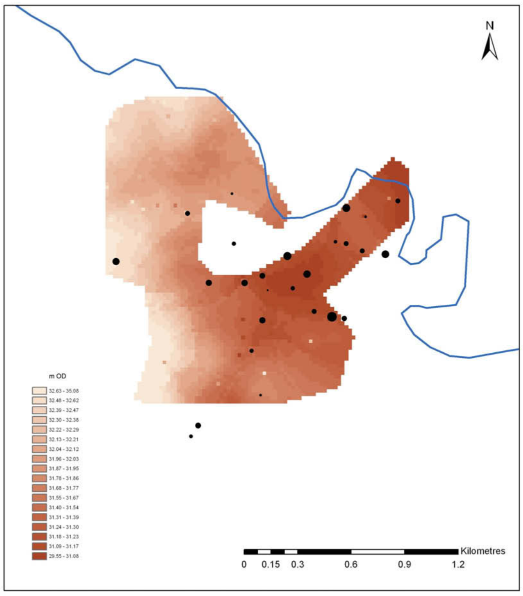
A: Surface geology, floodplain alluvium and terrace (line of profile in Fig 20 shown). Black circles indicate borehole observations used for DEM.



B: DEM of base of alluvial silt and clay. Black circles indicate location and thickness of peat.



C: DEM of base of sand and gravel. Black circles indicate location and thickness of peat.



D: DEM of top of till or bedrock. Black circles indicate location and thickness of peat.

Figure 19. DEM of the sub-surface topography of the Derwent Valley at (B) the base of alluvial silt and clay, (C) base of sand and gravel and (D) top of till/bedrock.

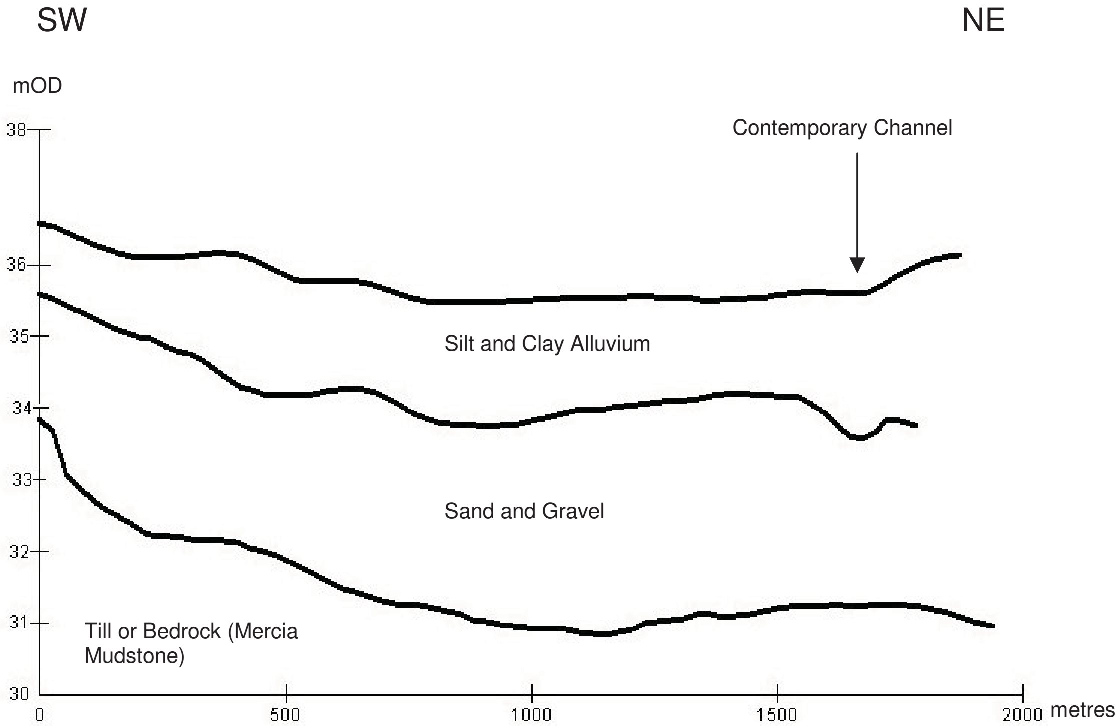


Figure 20. Profile through the alluvial stratigraphy of the Lower Derwent Valley as modelled by the sub-surface DEM (OD values are indicative).

The present DEM and profiles (Figures 19 and 20) record only details of fluvial drift and omit consideration of the fluvio-glacial till and boulder clay deposits encountered above bedrock at some locations. Notwithstanding this simplification, the DEM and profiles are broadly comparable with earlier interpretations of alluvial stratigraphy. In particular there are no clearly defined palaeochannels of the Derwent, although slight depressions in the top surface of the sand and gravel deposits hint at the presence of such features, which might also be indicated by the presence of peat and organic silts encapsulated within the floodplain alluvium at various locations.

Reach 4: The Trent Valley between the Dove and Blithe

This 30km river reach comprises the floodplain and lower terraces of the Trent between downstream confluence with River Dove in the east and the upstream confluence with the River Blithe in the west. In total 718 borehole records were available for study, these are summarised in table 6 and the alluvial stratigraphy mapped in Figure 21. The character of this reach is generally similar to reach 3. The floodplain is dominated by coarse grained sediments deposited in braided, anastomosing and meandering channels and fine grained accreted during overbank flooding. In contrast to reach 3 the valley here is narrower and the active floodplain of restricted width and dominated by a single channel.

Table 6 Summary of borehole observations for Reach 4, the Trent Valley between the Dove and Blithe.

	TVG 2002
Unit 1: Alluvium	199
Unit 2: Sand and Gravel	274
Organics	38
Unit 3: Rockhead	190
Total Boreholes	718

4.4.2 Three-Dimensional Sub-Surface DEM

In total 274 borehole records were used to produce sub-surface DEM for the base of sand and gravel (Figure 22) and top of the till or bedrock (Figure 23) of a section of the Trent between its confluence with the Rivers Dove and Blithe. The borehole data here although relatively sparse allowed the production of reasonably convincing DEM.

The principle feature evident in both DEM is a substantial south-west-north-east aligned sinuous depression in both the base of sand and gravel (Figure 23) and top of bedrock (Figure 24) to the west of the present main channel of the Trent. This depression underlies the river terrace deposits mapped by the Geological Survey and suggests that these coarse sediments infill a substantial bedrock cut trough, perhaps related to increased discharge during meltwater phases. The origins and geometry of these features are worthy of further investigation

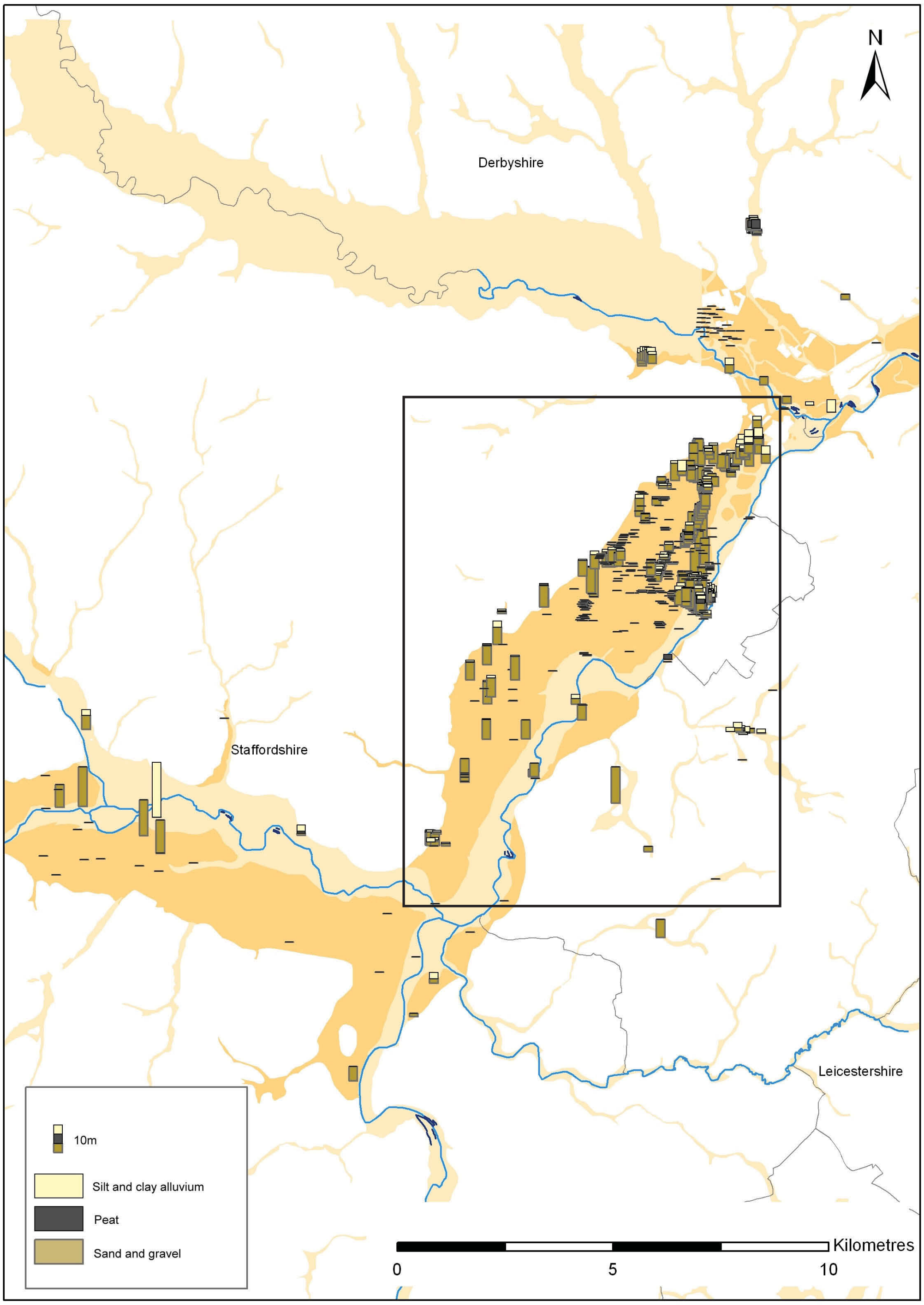


Figure 21. Map showing the extent of the floodplain and lower terraces of the Trent and the locations of all borehole records examined as part of the Trent Valley GeoArchaeology study within Reach 4, between the rivers Dove and Blithe. Borehole data are shown as stacked bar charts indicating the locations and thickness of the principal stratigraphic units. The area selected for three-dimensional sub-surface modelling is indicated by the black rectangle.

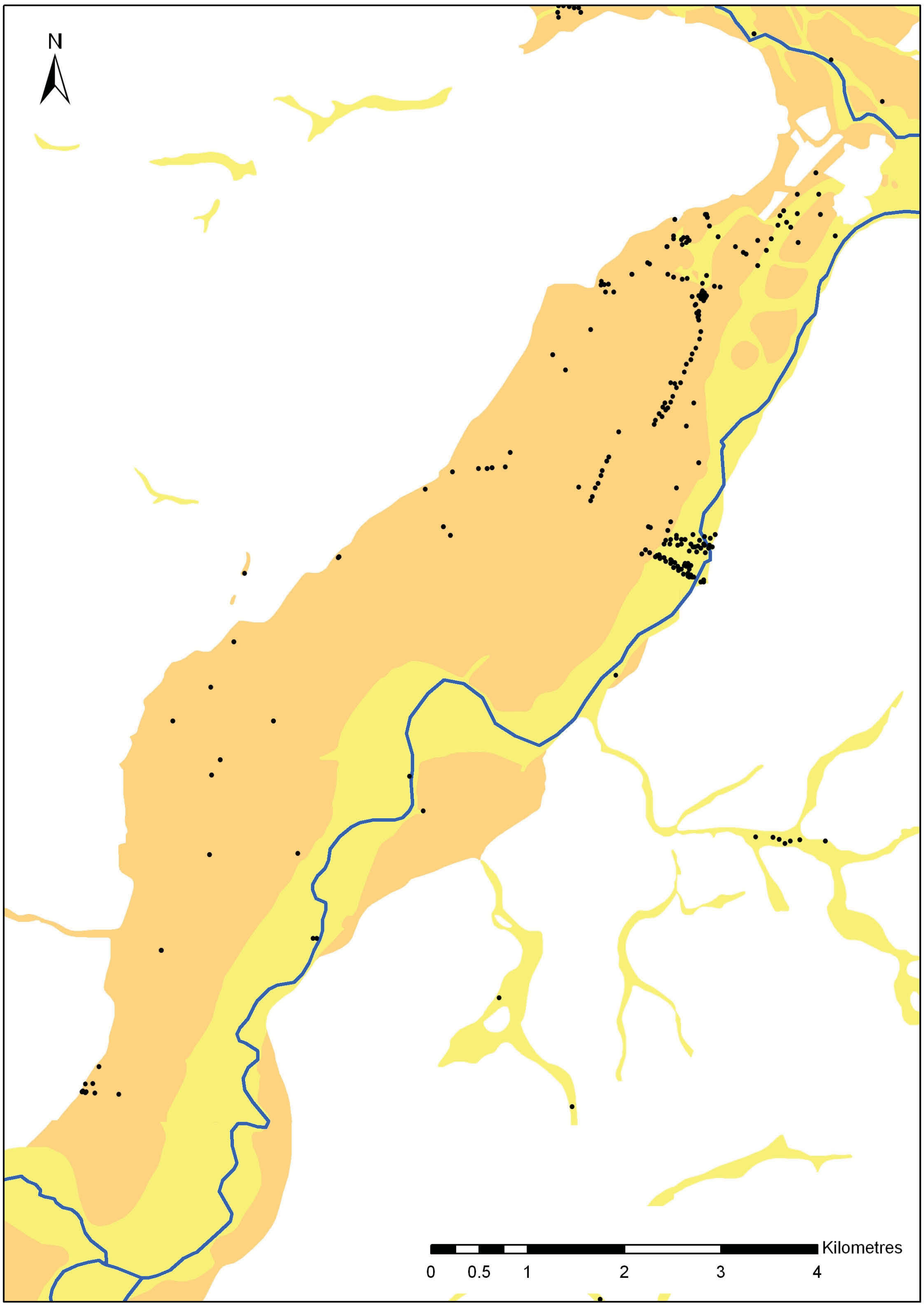


Figure 22. Map showing the extent of the floodplain and lower terraces of the Trent and the locations of all borehole records used for sub-surface DEM.

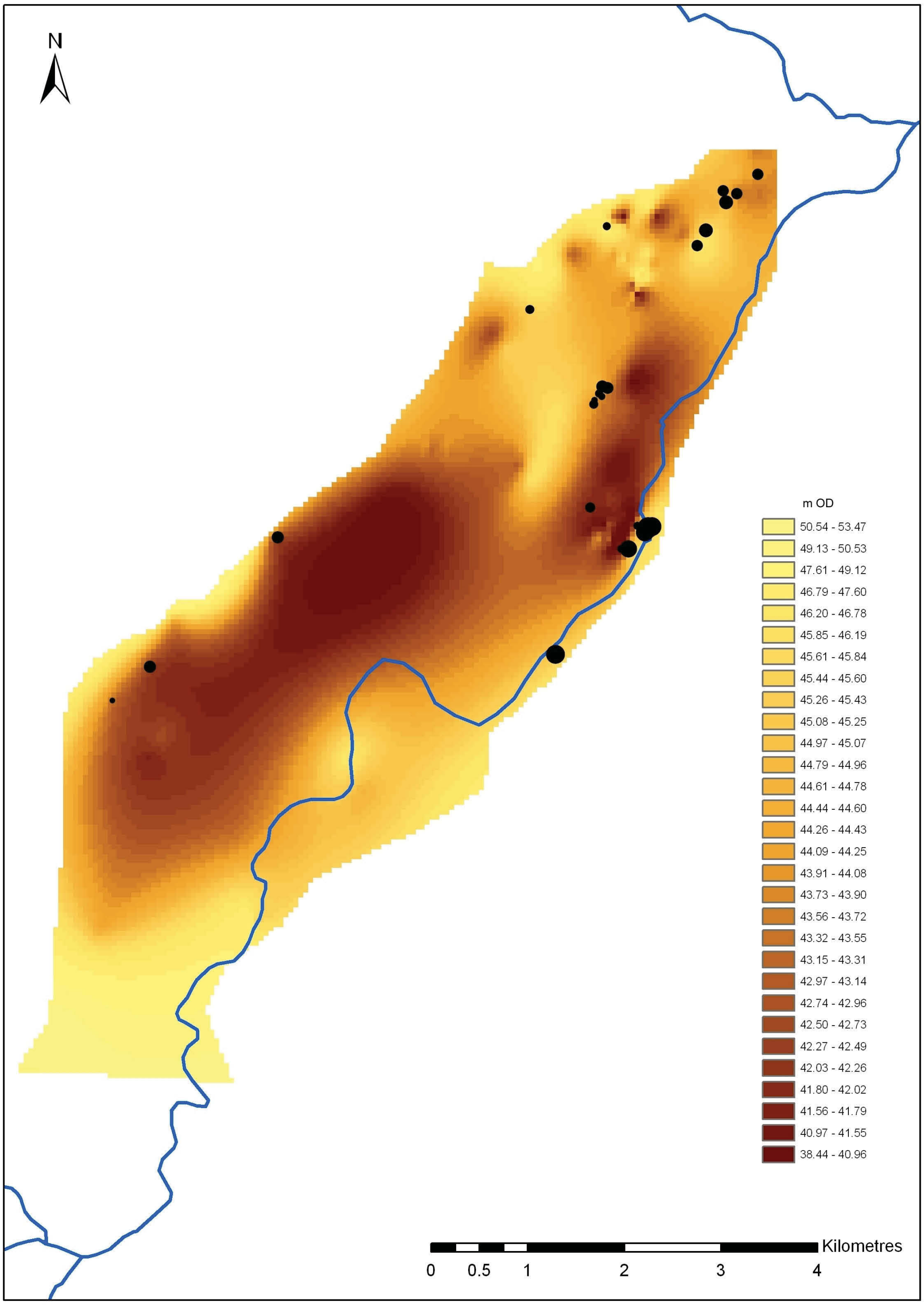


Figure 23. DEM of sub-surface topography at the base of sand and gravel. Black circles indicate locations and thickness of organic deposits.

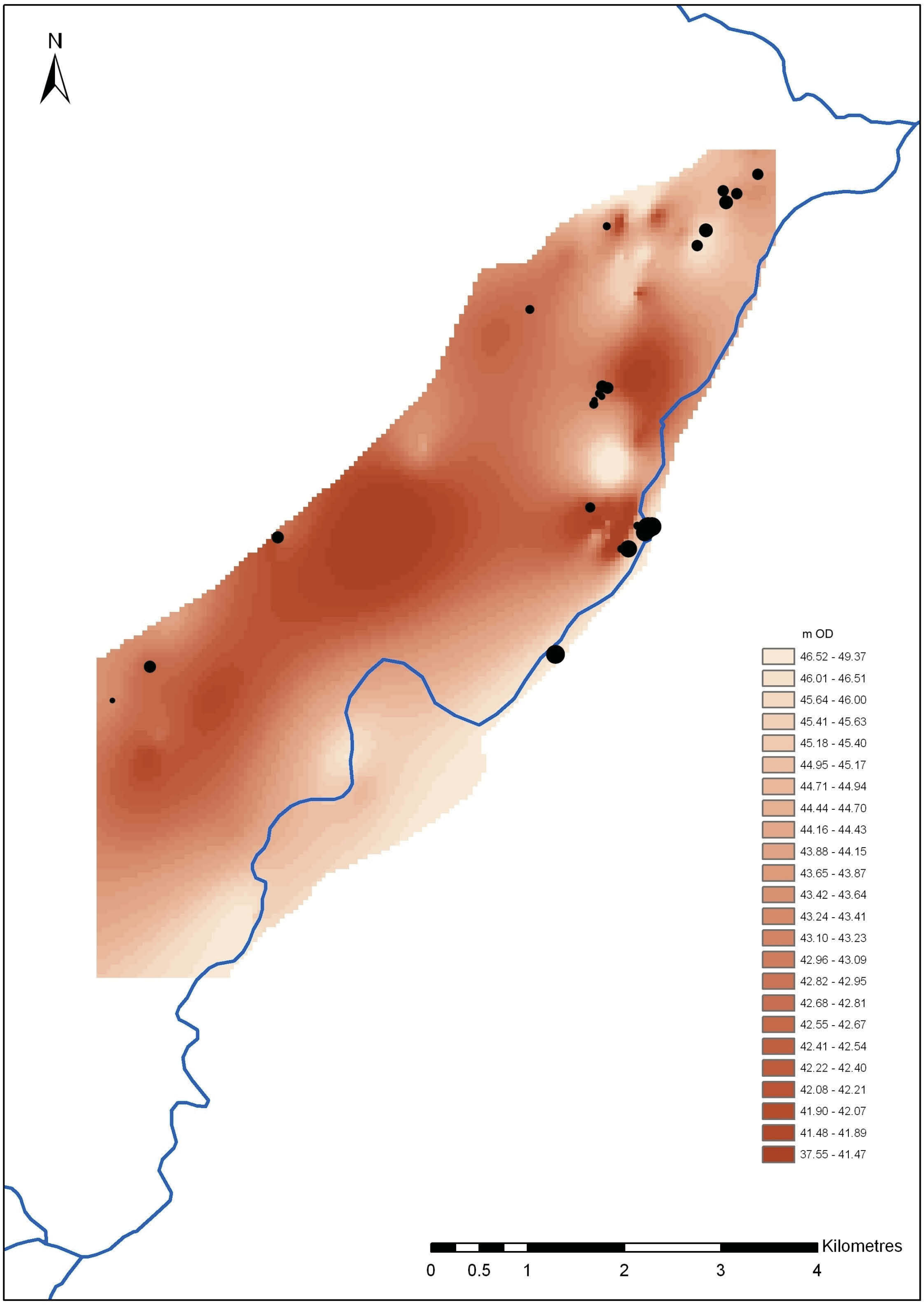


Figure 24. DEM of sub-surface topography at top of bedrock. Black circles indicate locations and thickness of organic deposits.

4.5 Reach 5: The Upper Trent Valley

This 30km river reach comprises the floodplain and lower terraces of the Trent upstream of the River Blithe as far as Stone. In total 177 borehole logs were examined for this reach, they are summarised in table 7 and illustrated in Figure 25.

Upstream of the River Blithe the character of the Trent Valley changes considerably. The valley is narrow and the Trent is characteristic of a high-energy upland river system (Howard and Macklin 1999) with dominance of coarse-grained sedimentation and limited fine-grained sedimentation. The narrow valley floor serves to prevent long-term preservation of terraces, palaeochannel and other relict floodplain features.

Table 7 Summary of borehole observations for Reach 5, the Upper Trent Valley.

	TVG 2002
Unit 1: Alluvium	25
Unit 2: Sand and Gravel	66
Organics	6
Unit 3: Rockhead	40
Total Boreholes	177

4.6 Reach 6: The Headwaters of the Trent

The final 25km river reach comprises the floodplain and younger terraces of the Trent upstream of Stone as far as the Head of Trent at Norton Green, together with the valleys of a number of minor tributaries such as the Lyme Brook. In total 418 borehole logs were examined, these are summaries in table 8 and illustrated in Figure 26. These data provide a useful picture of the alluvial stratigraphy of the Trent in area where much of the natural topography of the floodplain is heavily modified or the floodplain built upon. In particular it is worth noting the presence of peat and other organic material in 11 locations, indicating the palaeoecological potential of the Trent Valley in even this unpromising area where the floodplain surface may be obscured by buildings.

Table 8 Summary of borehole observations for Reach 6, the Headwaters of the Trent.

	TVG 2002
Unit 1: Alluvium	132
Unit 2: Sand and Gravel	160
Organics	11
Unit 3: Rockhead	120
Total Boreholes	418

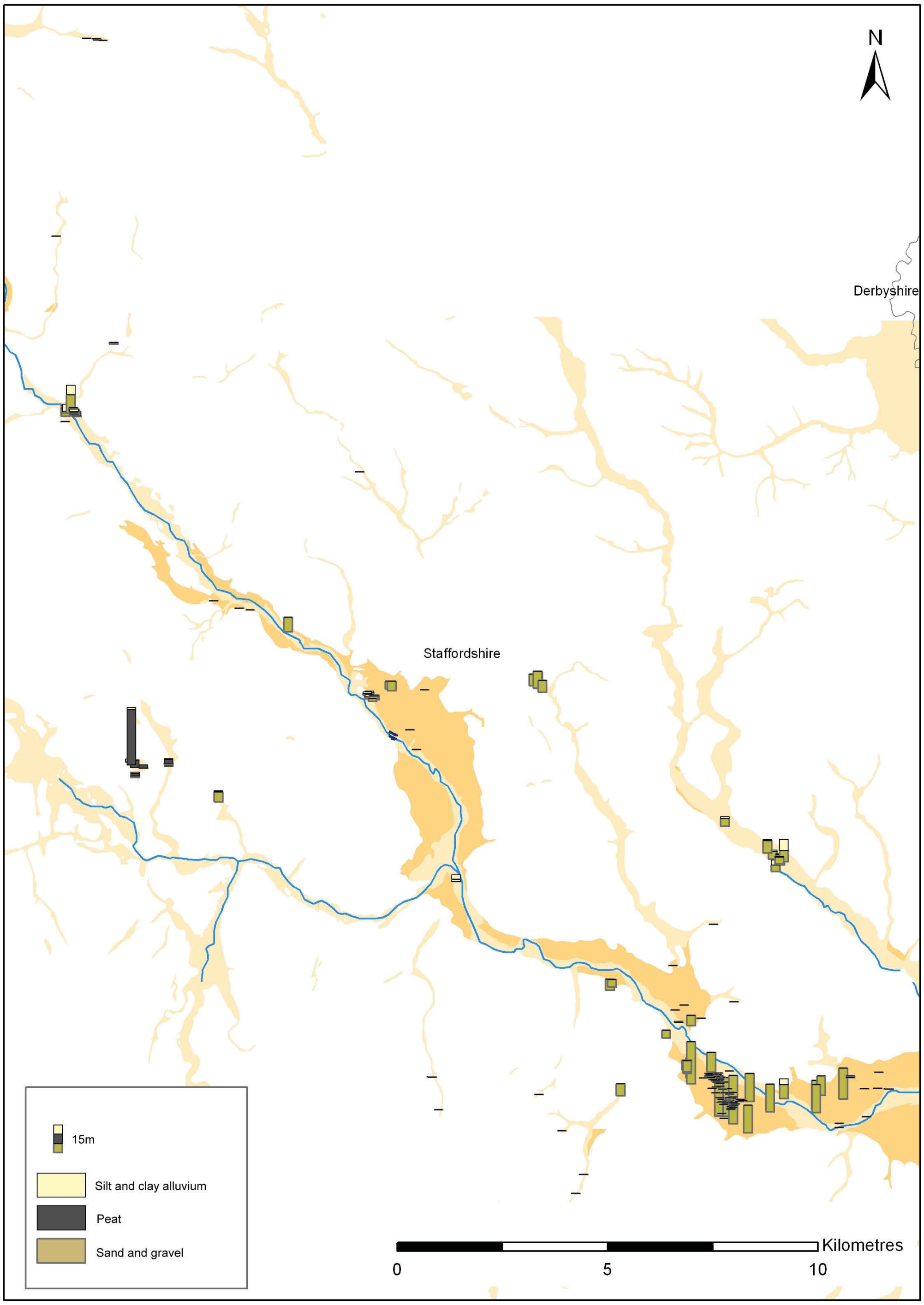


Figure 25. Map showing the extent of the floodplain and lower terraces of the Trent and the locations of all borehole records examined as part of the Trent Valley GeoArchaeology study within Reach 5, the Upper Trent Valley. Borehole data are shown as stacked bar charts indicating the locations and thickness of the principal stratigraphic units.

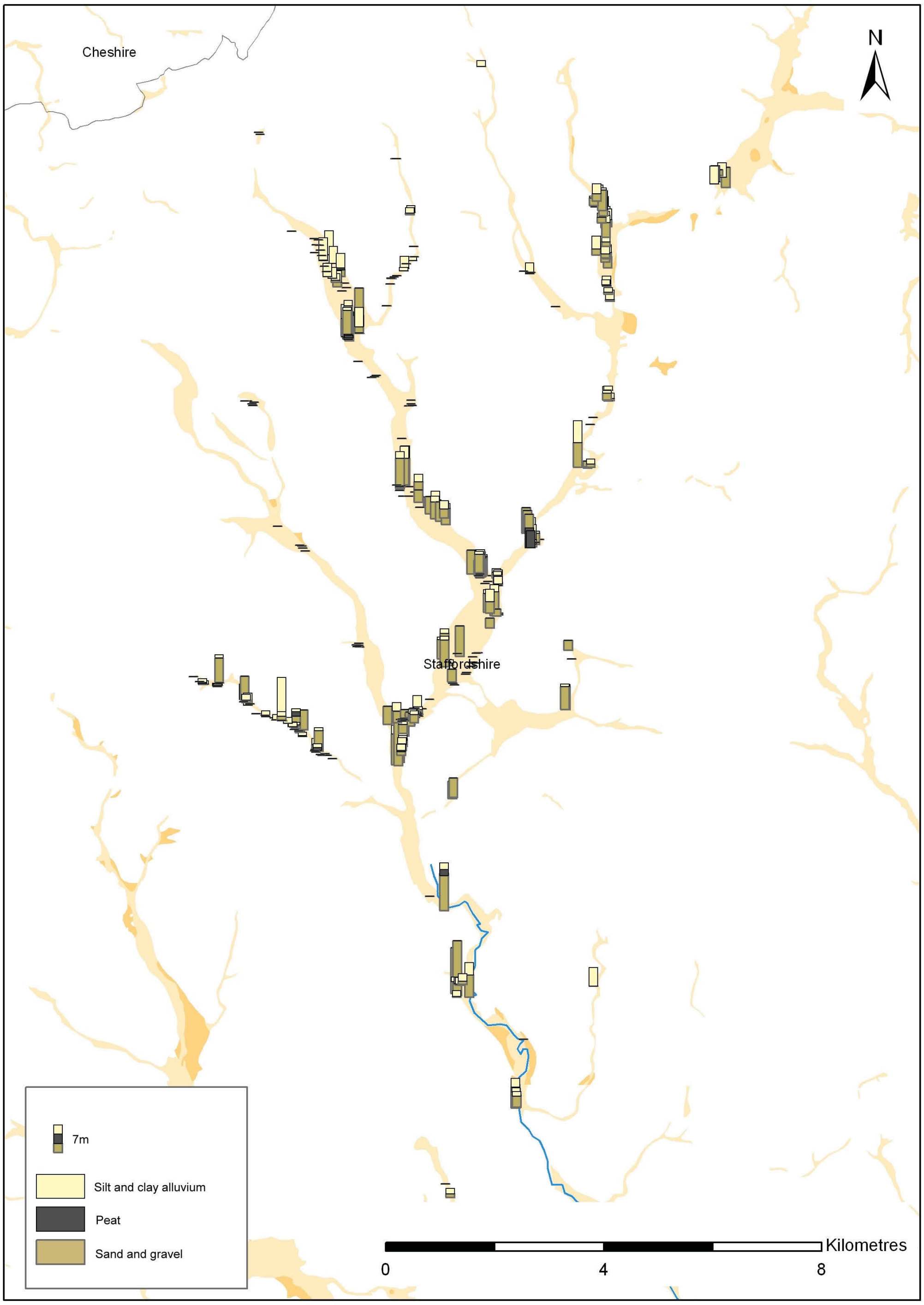


Figure 26. Map showing the extent of the floodplain and lower terraces of the Trent and the locations of all borehole records examined as part of the Trent Valley GeoArchaeology study within Reach 6, the headwaters of the Trent. Borehole data are shown as stacked bar charts indicating the locations and thickness of the principal stratigraphic units.

5 CONCLUSIONS AND RECOMMENDATIONS

The study has succeeded in compiling a database of some 2774 observation of the alluvial stratigraphy of the River Trent from borehole records. This data presented as a geodatabase and in proprietary GIS formats represents a significant new resource for those with interests in the geoarchaeology of the River Trent. Records of peat and other organic sediments at 202 locations, often in conjunction with palaeochannels mapped from air-photos by Steve Baker of T&PAU (Baker 2002) provide a useful complement to that resource and a guide to the palaeoecological potential of the floodplain.

The chief limitation of the data gathered in this research lies in the simplistic data model adopted, which is itself largely a product of the decision to use a database to digitise borehole observations, rather than specialist software. In retrospect this decision is a mistake and it is clear that the use of software designed specifically for digitising, modelling and visualising borehole data would have provided better results (see Bates and Bates 2000 and Bates 2003 for a comparison of methods and discussion of such software). In particular the need to impose a stratigraphic interpretation which fits the data model on the borehole data at the time of digitising, with no recourse to later amendment, is a severe limitation of the present method.

It is clear that the data model and method adopted for this study have reached the end of their usefulness: any further studies of the alluvial stratigraphy of the Trent and its tributaries should adopt the approach described by Bates (opp cit) together with the use of specialist borehole logging software. This has some resource implications. Packages tested by Bates included the prohibitively expensive Terrastation (cost in thousands of pounds) and the rather more reasonably priced Rockworks (costing about £600). The additional cost and possible need for training associated with use of such software should be borne in mind for future studies.

Attempts to model sub-surface topography and alluvial stratigraphy in three-dimensions have met with some success. In the three areas so modelled, sub-surface DEM provide useful illustrations of the alluvial stratigraphy of the Trent and a basis for discussion and review of the character of the valley.

The chief problems encountered in sub-surface modelling relate to the sparse distribution of borehole observations in many areas and the absence of records of Ordnance Datum level at the top of many boreholes, making calculations of OD levels for modelling reliant on the coarse records of elevation for the floodplain and terraces provided by the Ordnance Survey. It had been hoped that LiDAR terrain data would overcome this problem; in the event the incomplete distribution of LiDAR data for the Trent Valley has meant that it has not proven possible to use elevations derived from LiDAR in the modelling process. Thus, the sub-surface DEM should be seen as providing indicative models of sub-surface topography and stratigraphy as a spur to more detailed research.

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The staff at the British Geological Survey National Geosciences Data Centre at Keyworth gave unstinting help in gaining access to large numbers of borehole logs and they are sincerely thanked for their efforts and for the many, many file boxes moved.

APPENDIX 1. ARCHIVE CD-ROM CONTENTS AND USE

1 USING THE CD-ROM

The contents of the CD-Rom have been virus checked and are free from known viruses as of 10th February 2004.

The CD-ROM contains data in a variety of proprietary formats, together with data viewing software to enable use of the archive. CD contents are arranged as follows:

\tvg_2002_boreholes\access	Microsoft access database
\arcgis	ArcGIS files
\mapinfo	Mapinfo files
\ascii	ASCII DEM
\report	Report text
\software	Viewer software

The complete archive contents should be copied to the hard disk of the user's personal computer, maintaining the file system structure of the CD-ROM, before use.

2 CD-ROM CONTENTS

Microsoft Access Database

Filename: tvg_boreholes_2002.mdb (MS Access 2002 format)
tvg_boreholes_97.mdb (MS Access 97 format)

Data Structure

Tables:	Group1	Borehole data for reach 1
	Group2	Borehole data for reach 2
	Group3	Borehole data for reach 3
	Group4	Borehole data for reach 4
	Group5	Borehole data for reach 5
	Group6	Borehole data for reach 6

Fields within tables:

Field Name	Data Type	Description
Borehole_N	Text	Borehole Name (Provided by BGS)
Numb	Number	Borehole Number (Provided by BGS)
Qs	Text	OS 1:10000 Quatersheet
Bsuff	Text	Suffix
Easting	Number	NGR easting
Northing	Number	NGR northing
Bgs_id	Number	Uniqie ID (Provided by BGS)
OD_Top	Number	OD Value at top from log
U1_DTB	Number	Unit 1 depth to base from log
U1_Thickness	Number	Unit 1 thickness from log
U2_DTB	Number	Unit 2 depth to base from log
U2_Thickness	Number	Unit 2 thickness from log
U3_DTT	Number	Unit 3 depth to top from log
Organics_DTB	Number	Organics depth to base from log
Organics_thickness	Number	Organics thickness from log
Organics_Description	Text	Organics description summarised from log
CVSND_DTB	Number	Coversands depth to base from log (some tables only)
CVSND_thickness	Number	Coversands thickness from log (some tables only)
25FTDFT_DTB	Number	25-ft drift depth to bottom from log (some tables only)
25FTDFT_thickness	Number	25-ft drift thickness from log (some tables only)
Comments	Text	Comments
U1_Desc	Text	Unit 1 description summarised from log
U2_Desc	Text	Unit 2 description summarised from log
U3_Desc	Text	Unit 3 description summarised from log
CVSND_Desc	Text	Coversands description summarised from log (some tables only)
25FTDFT_desc	Text	25-ft drift description summarised from log (some tables only)
FGS&G_DTB	Number	Fluvio-glacial sand and gravel depth to base from log (some tables only)
FGS&G_thickness	Number	Fluvio-glacial sand and gravel thickness from log (some tables only)
FGS&G_Desc	Text	Fluvio-glacial sand and gravel description summarised from log (some tables only)
Elevation_from_TIN	Number	Elevation at borehole log abstracted from OS Panorama contour data

ArcGIS Format Files

Filenames:	group1.shp	Borehole data for reach 1
	group2.shp	Borehole data for reach 2
	group3.shp	Borehole data for reach 3
	group4.shp	Borehole data for reach 4
	group5.shp	Borehole data for reach 5
	group6.shp	Borehole data for reach 6

Data Structure
Each shape file comprises six constituent elements each with the same name but with differing extensions, eg files for group1 comprise:

group1.shp
group1.dbf
group1.prj
group1.sbn
group1.sbx

It is essential to copy all files for each group to the same directory when moving data.

MapInfo Format Files

Filenames:	group1.tab	Borehole data for reach 1
	group2.tab	Borehole data for reach 2
	group3.tab	Borehole data for reach 3
	group4.tab	Borehole data for reach 4
	group5.tab	Borehole data for reach 5
	group6.tab	Borehole data for reach 6

Data Structure
Each mapinfo file comprises four constituent elements each with the same name but with differing extensions, eg files for group1 comprise:

group1.tab
group1.map
group1.id
group1.dat

It is essential to copy all files for each group to the same directory when moving data.

ASCII Format Files
ASCII files are provided for each of the ArcGIS grids produced for sub-surface models in the three study areas.

Filenames:	g1u1odb.asc	Reach 1 base of unit 1
	g1u2odb.asc	Reach 1 base of unit 2
	g1u3odb.asc	Reach 1 top of unit 3
	g3u1odb.asc	Reach 3 base of unit 1

g3u2odb.asc Reach 3 base of unit 1
g3o3odb.asc Reach 3 top of unit 3

g4u1odb.asc Reach 4 base of unit 1
g4u2odb.asc Reach 4 base of unit 1
g4u3odb.asc Reach 4 top of unit 3

Data Structure
The ASCII raster file format is a simple format that can be used to transfer raster data between various applications. It comprises a few lines of header data followed by lists of cell values. The header data includes the following keywords and values:

- ncols - number of columns in the data set.
- nrows - number of rows in the data set.
- xllcenter or xllcorner - x-coordinate of the centre or lower-left corner of the lower-left cell.
- yllcenter or yllcorner - y-coordinate of the centre or lower-left corner of the lower-left cell.
- cellsize - cell size for the data set.
- nodata_value - value in the file assigned to cells whose value is unknown. This keyword and value is optional. The nodata_value defaults to -9999.

For example,

ncols 480
nrows 450
xllcorner 378923
yllcorner 4072345
cellsize 30
nodata_value -32768
43 3 45 7 3 56 2 5 23 65 34 6 32 etc
35 45 65 34 2 6 78 4 38 44 89 3 2 7 etc
etc

The first row of data is at the top of the data set, moving from left to right. Cell values should be delimited by spaces. No carriage returns are necessary at the end of each row in the data set. The number of columns in the header is used to determine when a new row begins. The number of cell values must be equal to the number of rows times the number of columns.

Report
A copy of this report text is provided in Adobe portable document format. A copy of the report on borehole modelling in the Nottinghamshire Trent (Challis 2001) is also provided.

Filenames: tvg2002_component3_report.pdf
Challis_2001.pdf

Software

Software for viewing Adobe portable document format files, ArcGIS data and Mapinfo data are provided. These are binaries executable files allowing installation of the software to the user's personal computer to enable use of the archive.

Filename: AdbeRdr60_enu_full.exe (Adobe Acrobat pdf viewer version 6)
acrruserguide.pdf (Adobe Acrobat viewer manual)
aeclient.exe (ArcExplorer GIS data explorer version 2)
arcexplorer.pdf (ArcExplorer manual)
Proviewer70.exe (Mapinfo Proviewer version 7)
Proviewer70.pdf (Mapinfo Proviewer manual)

3 COPYRIGHT STATEMENT

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