

**TRENT VALLEY 2002:  
ADVANCING THE AGENDA IN ARCHAEOLOGY AND ALLUVIUM**

# **The Trent Valley: palaeochannel mapping from aerial photographs**

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**Trent Valley GeoArchaeology**

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## **COMPONENT 2A**

# **PALAEOCHANNEL MAPPING FROM AERIAL PHOTOGRAPHS**

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*The Trent is a highly mobile river and has left earlier channels scattered across its floodplain. These are a key consideration in the holistic landscape approach to the understanding of the relationship between settlement and the river, to the prediction of certain types of site (such as burnt mounds), to the location of well-preserved organic remains, and in risk management. Plotting of palaeochannels, already undertaken for the Trent floodplain in Nottinghamshire, has been extended to cover the whole Trent Valley area.*

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# 1. INTRODUCTION

While the cultural archaeology of the gravel terraces and floodplain of the River Trent is relatively well documented, there has been less systematic investigation of geoarchaeological character or potential. Palaeochannels in particular are of significance within the alluvial landscape, as their fill often contains material of palaeoecological value and channel margins may be the location for cultural activity. The objective of this project component was therefore to extend the extensive survey already carried out in Nottinghamshire (Malone 1998, Challis *et al.* 1999) to the remainder of the Trent floodplain and terraces.

Palaeochannel mapping in a durable Geographical Information System (GIS) format has therefore been produced. The GIS includes:

- a base map of the study area, including low-resolution Ordnance Survey topological and topographic data, drift geology from the British Geological Survey, parish boundary data from EDINA, and historic mapping from the Ordnance Survey;
- shapefile data showing palaeochannels and areas of ridge-and-swale topography, digitised from a mosaic of rectified vertical aerial photographs;
- attribute data, attached to the palaeochannel features, combining basic classification and location, metadata such as the original information source for the mapped channel, and observations from Ordnance Survey 1 inch historic mapping and parish boundary data.

In conjunction with the results of Component 2b (LiDAR terrain modelling) and Component 4 (Alluvium depth and character modelling), it is envisaged that this dataset will be used as follows:

- to inform the syntheses of archaeology and palaeoenvironment undertaken as part of the wider Trent Valley 2002 project;
- to inform the archaeological risk map also to be produced as part of the project;
- to provide new information for the Sites and Monuments Records of participating local authorities to assist in strategic management of the geoarchaeological resource.

## 2. METHOD STATEMENT

The methods used have been based extensively on the pioneering study of Nottinghamshire palaeochannels, commissioned by Nottinghamshire County Council in 1999 (Malone 1998, Challis *et al.* 1999). Work has been undertaken largely within ESRI's ArcView 3.2 GIS, supplemented by ERDAS Imagine 8.6 image-processing software for the rectification of aerial photographs. This software was selected because of its familiarity to the project team and its widespread use within the research community. Where necessary, the final data will be distributed to end users in participating local authorities in other proprietary formats.

### Defining the project area

The project area for Trent Valley 2002 (see for example Challis 2002 figure 2) is defined by a 10-km-wide corridor centred on the River Trent. However, the digital palaeochannel plots produced for the Nottinghamshire survey (Challis *et al.* 1999) show that palaeochannel features visible from the air are concentrated within a somewhat narrower zone. On closer examination, it could be demonstrated that *all* the Nottinghamshire features fell within a zone defined by the alluvial floodplain of the Trent, and the more recent (Flandrian and Devensian) gravel terraces, henceforth referred to as 'Floodplain Terrace' deposits (Figure 1).

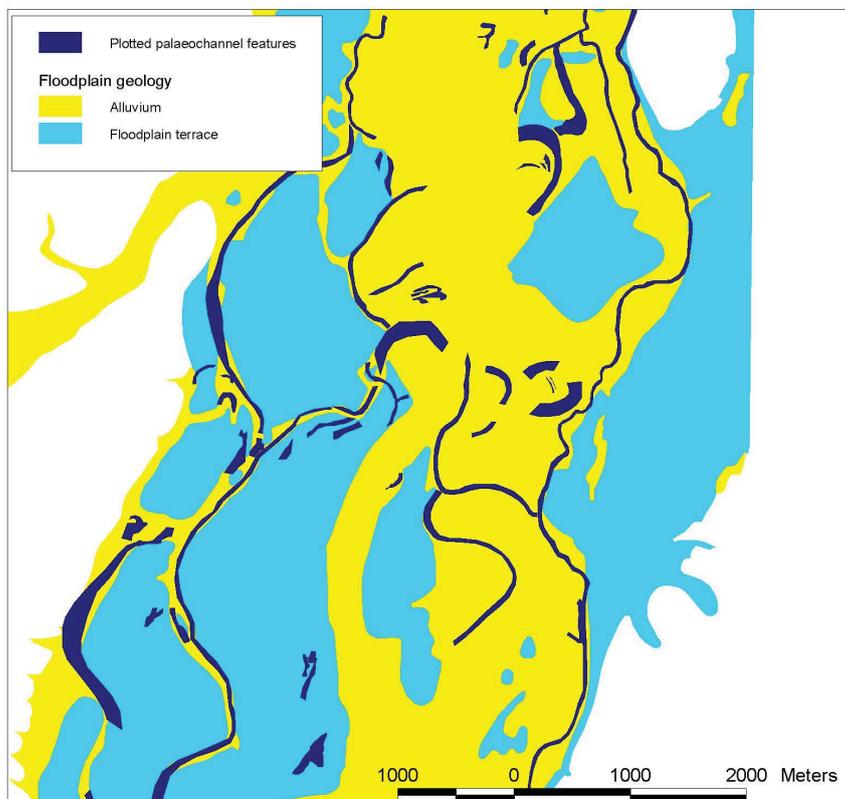


Figure 1: plotted palaeochannel features in relation to alluvium and 'floodplain terrace' in the Nottinghamshire Trent Valley

It was decided, therefore, to further restrict the project area, for Component 2a, on the basis of digital drift geology data (DiGMapGB) obtained at 1:50000 from the British Geological Survey. Within this data, the following terrace deposits were identified as forming part of the 'Floodplain Terrace':

- River Terrace Deposits, 1
- Ambaston Terrace
- Hemington Terrace
- Syston Sand and Gravel
- Holme Pierrepont Sand and Gravel
- Allenton Sand and Gravel
- Wanlip Sand and Gravel
- Beeston Sand and Gravel
- Scarle Sand and Gravel

These deposits, together with the alluvial floodplain of the Trent, were combined to define a new project area for Component 2a (Figures 2 and 3). The lower reaches of major tributaries (Soar, Derwent, Dove and Tame) were included; minor tributaries were excluded. To the west of the confluence of the Trent with the Humber estuary, the watershed between the Trent and the Humberhead levels was used as an additional cut-off point on very extensive alluvial deposits. Nottinghamshire was subtracted from the project area due to the existing study.

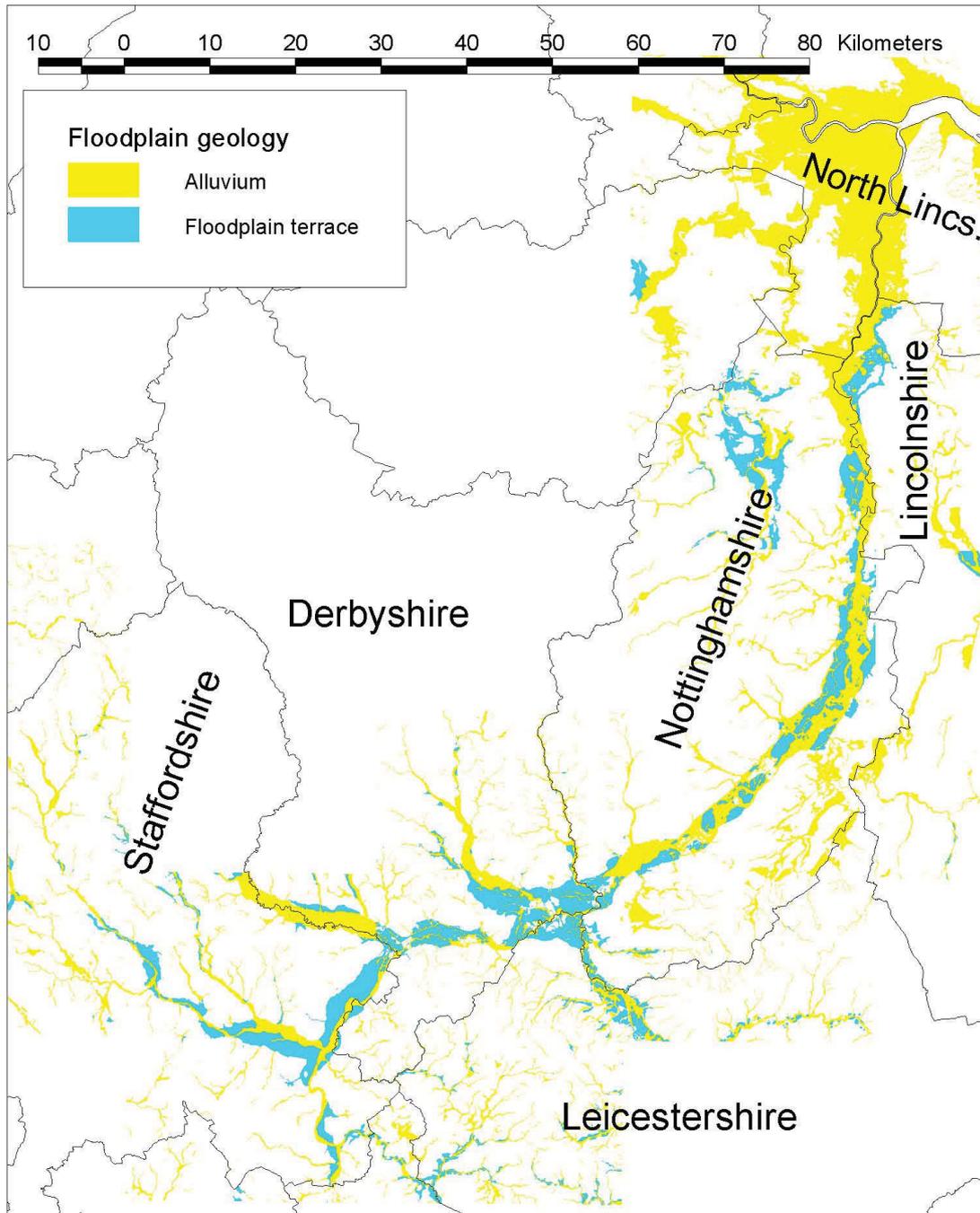


Figure 2: floodplain drift geology along the entire Trent Valley.

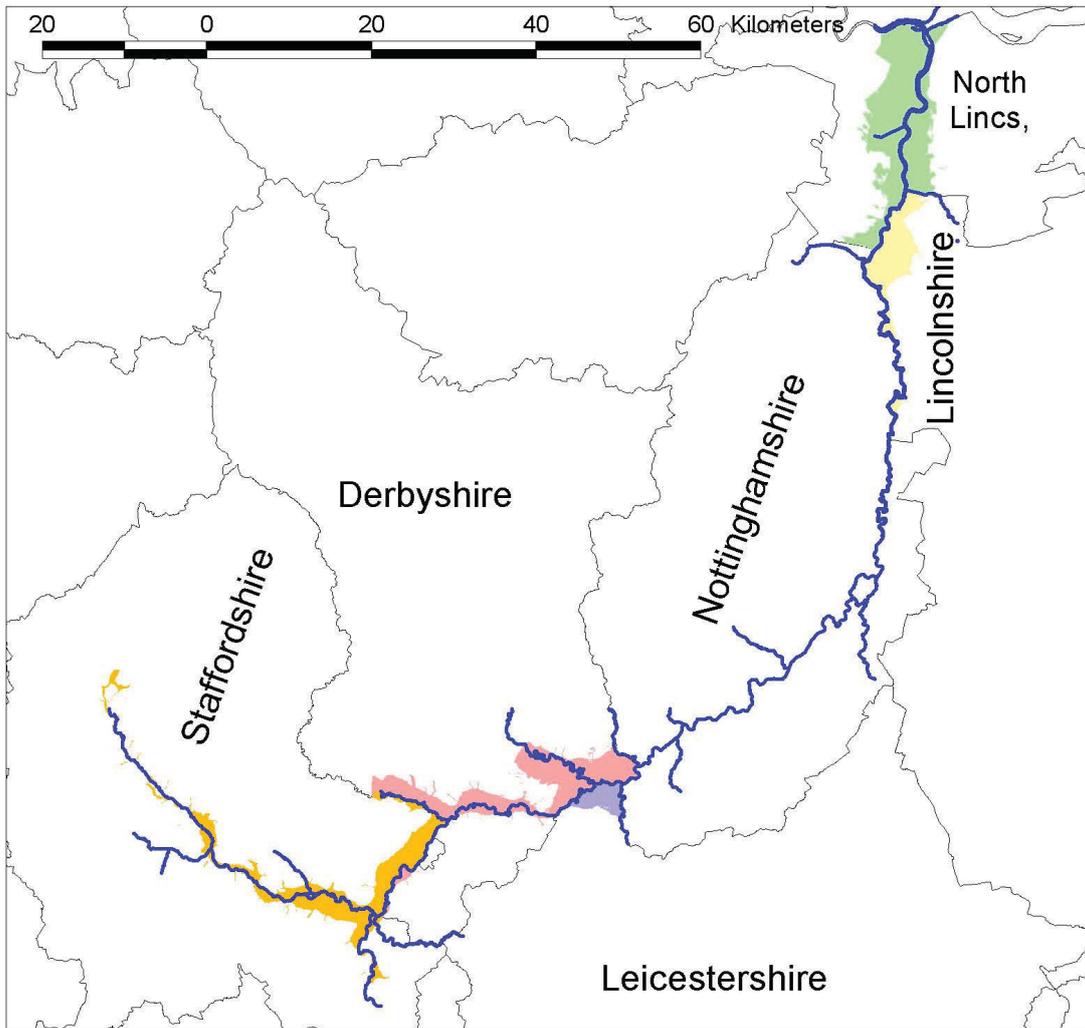


Figure 3: project area for palaeochannel plotting, defined by county excluding Nottinghamshire

## GIS Base Map Layers

### Ordnance Survey base map

Ordnance Survey 1:50000 scale colour raster images, supplied in 20km x 20km tiles, were downloaded from the EDINA Digimap service and assembled to provide a general topological and topographic background for the project area. These images were also used later in the rectification of aerial photographs, to provide reference control points.

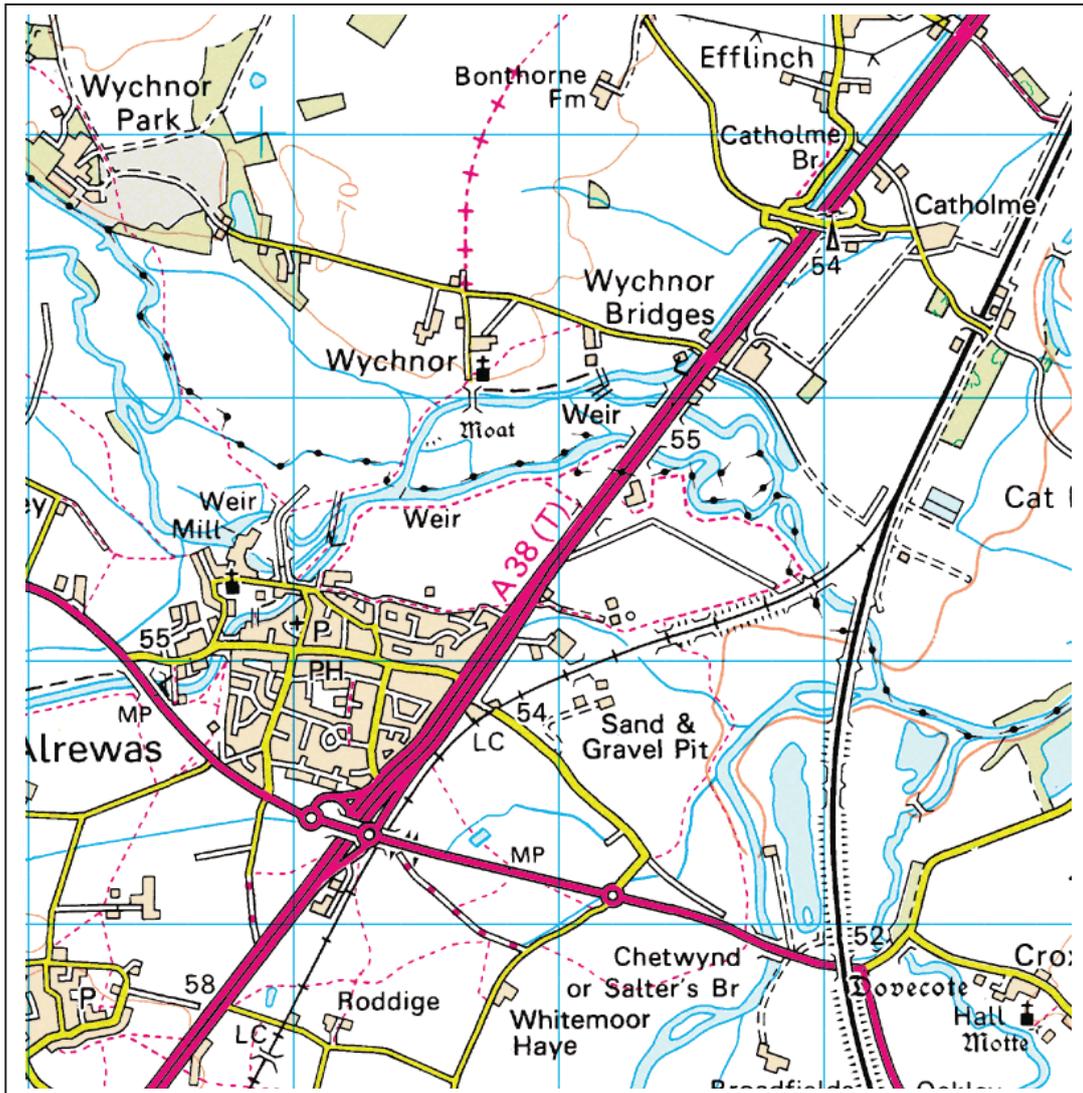


Figure 4: Ordnance Survey base map layer (sheet SK00) showing the Trent/Tame confluence near Alrewas, Staffs.

## Vector topographic data

Ordnance Survey Panorama 10m contour data, also supplied in 20km x 20km tiles, were downloaded from the EDINA Digimap service and assembled to provide a single seamless 10m contour shapefile for the whole project area. This 10m contour dataset was subsequently used within ArcView to build a Digital Terrain Model (DTM), providing continuous elevation values for the study area.

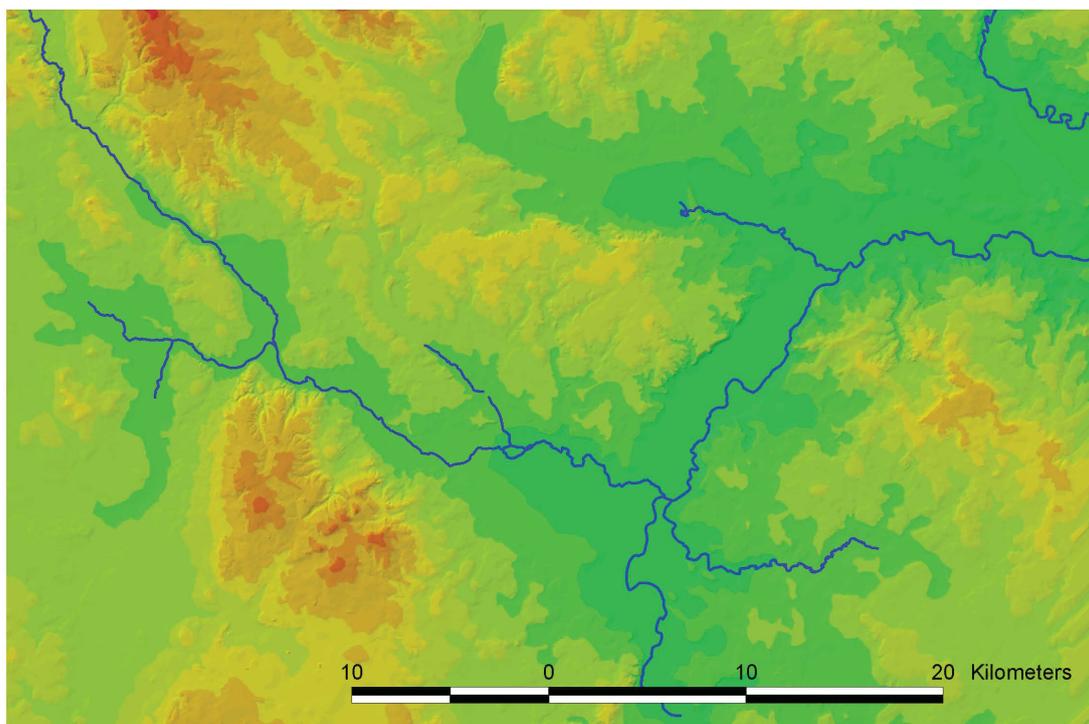


Figure 5: DTM data for the Staffordshire Trent Valley

## Drift geological data

The British Geological Survey's DiGMap 1:50000 digital dataset was obtained in ArcView shapefile form, in 20km x 20km tiles. These were assembled to produce a single seamless shapefile for the drift geology of the project area. Legend files were subsequently generated within ArcView, to simpler thematic views of the drift geological formations of particular relevance to the survey, for example showing floodplain alluvium and floodplain terrace only, or alluvium, floodplain terrace and earlier gravel terraces. As discussed above, this dataset was used to refine the project area for Component 2a. In addition, a BGS dataset was obtained showing areas of worked-out or made ground. It was hoped that this would be of use in ascertaining where palaeochannel features, mapped from 1970s or 1940s photographs, survive today. Unfortunately this dataset only exists for recently surveyed geological sheets, and only overlaps with the project area on one sheet. In general, however, blank patches within floodplain drift geology (see for example Figure 6 below) correspond to these areas of worked-out or made ground, or, more rarely, to areas of solid geology.

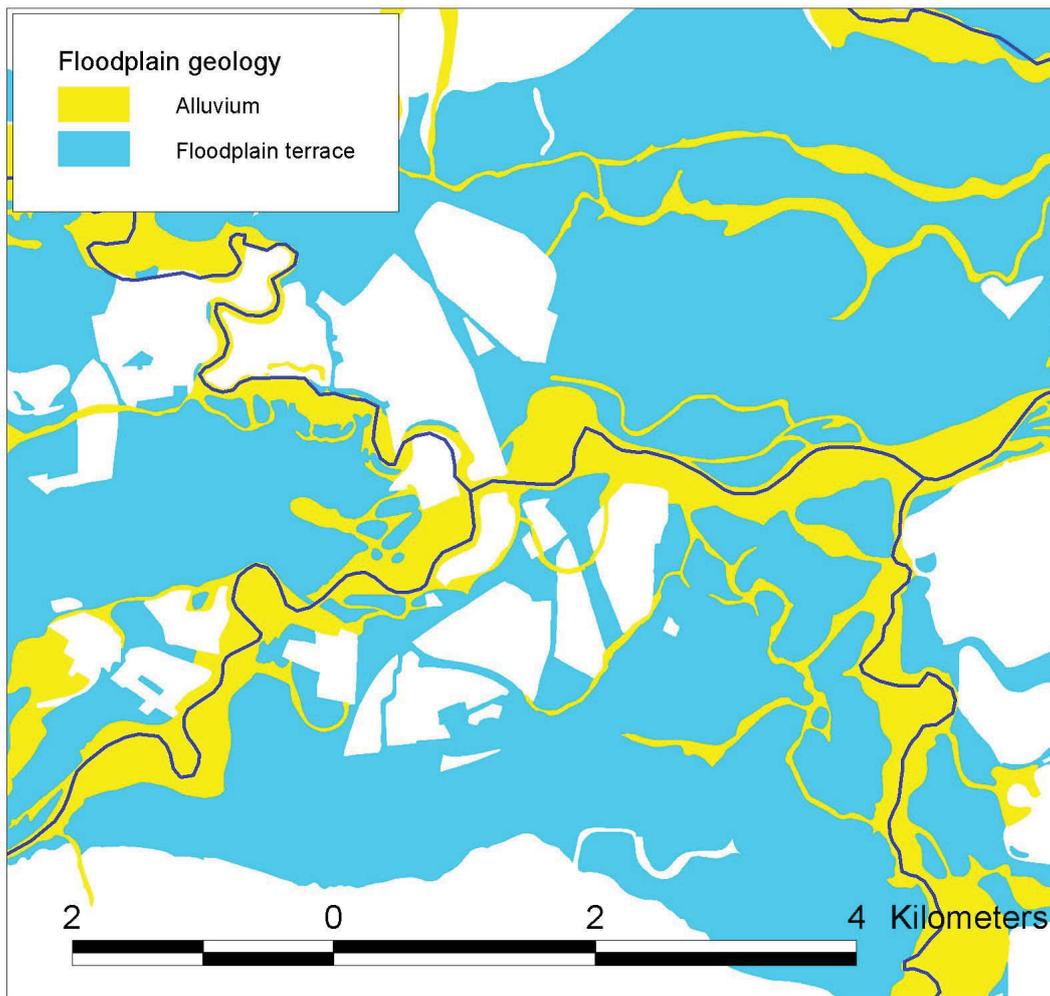


Figure 6: floodplain drift geology around the Trent/Soar and Trent/Derwent confluences

### Historic Mapping

Ordnance Survey 1 inch 1<sup>st</sup> Edition maps (reprinted by David and Charles, Newton Abbott) were initially scanned at 400 dpi. These scans were then trimmed for the project area and rectified within ERDAS Imagine 8.6. The rectified images were converted into grid datasets within ArcView. As noted in the Nottinghamshire study (Challis *et al.* 1999) it was not possible to produce rectified images that were geo-referenced precisely with modern maps. This is probably due to inaccuracies in the original mapping process or in the modern reproduction, and to distortions introduced in the scanning process. It was, however, possible, to achieve a good enough fit to allow river courses on the historic and modern maps to be compared. This allowed a number of instances to be identified where palaeochannel features appear to have resulted from relatively recent river management, and this information has been incorporated within the attributes attached to such features within the GIS.

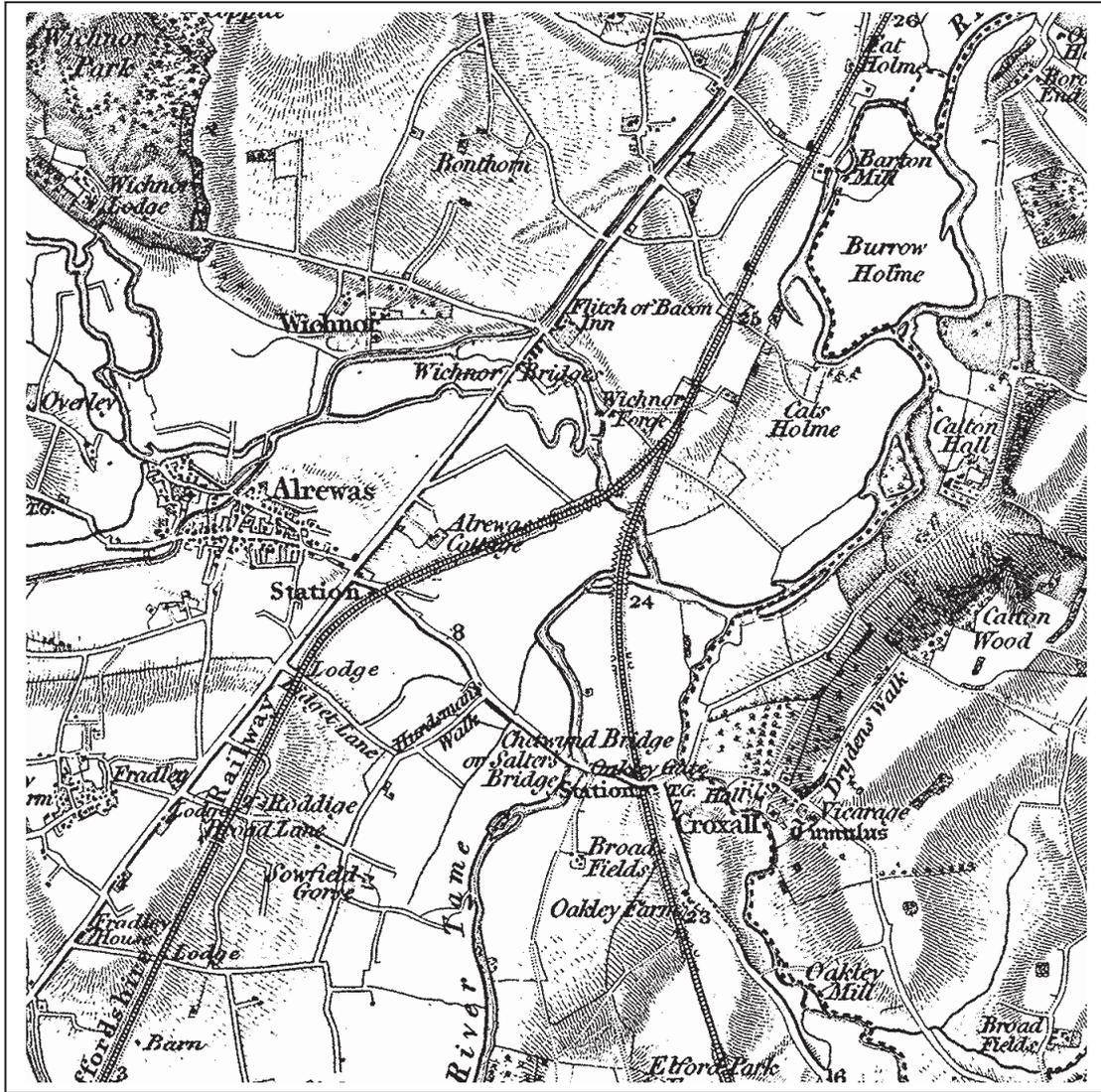


Figure 7: Ordnance Survey 1 inch 1<sup>st</sup> edition map showing the Trent/Tame confluence near Alrewas, Staffs.

From the reprint of the first edition of the one-inch Ordnance Survey map of England & Wales, Sheet 42, Lichfield and Birmingham (David & Charles, 1970) by kind permission of the publishers.

### Parish boundaries

A parish boundary dataset has been obtained in ArcView shapefile form from the EDINA Census UK service. A number of instances have been identified where palaeochannels visible from the air are followed by a parish boundary, suggesting that a major channel existed at the time of boundary definition. Rather fewer examples have been noted where a parish boundary diverges from a major watercourse in such a way as to suggest the existence of an earlier channel course, without any palaeochannel being visible from the air. In both cases, this information has been incorporated within the attributes attached to features within the GIS.



Figure 8: parish boundary data south of Gainsborough, Lincs.

## **Aerial photograph acquisition and processing**

The Nottinghamshire survey suggested that county surveys carried out commercially during the 1970s offered complete vertical coverage of the project area, in addition to generally sharp prints with good visibility of floodplain features. It was decided to use these photographs as a primary source of information (subject to visits to county SMRs to assess the quality and coverage available).

In addition, the Nottinghamshire study suggested that 1940s RAF verticals could provide supplementary information where subsequent ploughing of the floodplain, gravel extraction, or other development had destroyed palaeochannel features or rendered them invisible from the air. The quality of the 1940s photographs was however far more variable, and therefore required careful assessment during the identification stage.

### **Identification and acquisition**

1970s photographs were identified through visits to county Sites and Monuments Records in participating local authorities (Derbyshire, Leicestershire, Staffordshire and Lincolnshire County Councils) and at North Lincolnshire Council. Likely photographs were identified by reference to a key map, and then inspected individually. Due to unforeseen circumstances, it was only possible to obtain patchy coverage of the North Lincolnshire project area with 1970s photographs. These were supplemented by photographs from the 1980s, but some gaps remained, particularly in the Isle of Axholme area. It was decided to use the 1940s photographs as the primary set here.

Photographs for Leicestershire, Staffordshire, Lincolnshire and North Lincolnshire were scanned *in situ* from the original prints. Copyright for the Derbyshire photographs resided with the original operator, Simmons Aerofilms; it was therefore necessary to purchase prints, which were then scanned.

All prints were scanned at 150dpi, to TIF format. It was felt that this resolution was sufficient to allow palaeochannel features to be readily identified, without generating extremely large image files that would slow down subsequent processing.

The 1940s RAF coverage is held by the National Monuments Record in Swindon. Initially, an aerial cover search for the project area was carried out on their collection, to identify the full range of photography available. This yielded in the region of 4000 photographs. In order to reduce this to a manageable level, and to identify the sorties offering the highest quality coverage, five sample areas of 2km x 2km were defined, one for each county within the project area. An additional cover search was carried out on the sample areas, yielding around 120 prints. These were individually examined during a visit to the NMR, and this enabled a number of key sorties to be identified, offering a high or at least acceptable quality of coverage for different parts of the project area. In addition, each individual sortie was digitised within ArcView to enable overall coverage and potential overlaps to be examined. This information,

together with the key sorties identified from the sample prints, enabled a total of 381 prints to be ordered, giving complete, duplicate-free coverage of the project area, and the promise of acceptable print quality. The prints were scanned at 150dpi by the NMR, and delivered in TIF format. Of the 381 prints, only a handful were of low quality or obscured by cloud cover, thus bearing out the sampling process adopted.

	<b>Derbys. (1970s)</b>	<b>Leics. (1970s)</b>	<b>Staffs. (1970s)</b>	<b>Lincs. (1970s)</b>	<b>N. Lincs (1970s/80s)</b>	<b>RAF (1940s)</b>
<b>Number</b>	40	26	36	78	61	381

Table 1: numbers of photographs acquired for each county (1970s) and for the project area as a whole (1940s).



Figure 9: raw photo scan: the Trent at East/West Stockwith, Lincs.. HSL/UK/71/79/2115  
© Lincolnshire County Council

## **Processing and rectification**

Raw photo scans were trimmed to remove borders, cross-hairs and other marginal features. They were also subjected to a monochrome histogram stretch in order to enhance the contrast within the image and thus the visibility of palaeochannel features.

The 1940s coverage was subjected to a pre-selection process to reduce the number of photographs to be rectified. Raw scans were compared with the palaeochannel plots already produced from the 1970s coverage. Only those prints which appeared to show extra information, or to refine the existing plots, were selected for rectification. In parts of North Lincolnshire where 1970s coverage was incomplete, all the 1940s photographs were selected, whether or not they appeared to show palaeochannel features. This process allowed the original 381 prints to be reduced to 190 for rectification.

Each scan was rectified within ERDAS Imagine 8.6. Control points on the aerial photograph were paired with reference control points on a map image. The Ordnance Survey 1:50000 colour raster images were used for this purpose. The reasonably level contours of the Trent floodplain allowed a polynomial order 2 transformation to be used, requiring a minimum of 6 control points, though in practice rather more were used (typically between 8 and 15, depending on the photograph). An error in the rectified image of up to 10m was considered acceptable, due to the large coverage and consequent low resolution of the project. In practice, reported error was much smaller than this, typically in the region of <5m, though some mismatch can be seen at the edges of rectified images, particularly where few control points were available.

Scans were then resampled to produce rectified images at a resolution of 1 pixel = 2m. Rectified images were stored in .img format (Imagine raster viewer) for use in ArcView.



Figure 10: rectified image of Figure 9, overlaid on OS base map layer.  
Photo image © Lincolnshire County Council

## Palaeochannel identification and plotting

### How palaeochannels show

Rectified aerial photographs provided the main data source for the identification and plotting of palaeochannels. In addition, historic mapping and parish boundary data were examined for further information. Palaeochannels may be visible from the air in a number of forms:

1. Relict channels where standing water remains either permanently or seasonally. Visibility of these features may be enhanced during winter flooding.



Figure 11: standing water in palaeochannel, Castle Donington, Leics. Aerofilms 7145/10/736 (1971) © Simmons Aerofilms Ltd.

2. Visible depressions in the floodplain surface (this category may overlap with 1., particularly during flooding episodes). In general, these features survive when the floodplain has not been ploughed.



Figure 12: visible depressions, Hemington, Leics.: Aerofilms 7145/12/191 (1971) © Simmons Aerofilms Ltd.

3. Cropmarks, soilmarks, moisture marks. The enhanced moisture content of palaeochannel features may cause a differential in the colour of soils or vegetation, or in vegetation growth. These features can be seen in areas of ploughing (cropmarks, soilmarks) and on the floodplain (moisture marks).



Figure 13: cropmark palaeochannels (arrowed), Marston-on-Dove, Derbys. Aerofilms 7145/13/390 (1971) © Simmons Aerofilms Ltd.

4. Bands of vegetation. Enhanced moisture and organic content in palaeochannel features, and/or a relatively undisturbed environment where such features remain undeveloped (for example through acting as a boundary) may lead to the development of a band of trees or scrub over a feature.



Figure 14: palaeochannel visible as a band of scrub, Trent/Soar confluence, Leics. Aerofilms 7145/9/768 (1971) © Simmons Aerofilms Ltd.

5. Boundary features (field boundaries, hedges, fences, walls). While boundary features often follow palaeochannel features of the above types, there are many cases where boundaries appear to follow old watercourses where no other evidence is visible from the air.



Figure 15: hedgeline (arrowed) appears to suggest course of former channel, Long Eaton, Derbys. Aerofilms 7145/10/632 (1971) © Simmons Aerofilms Ltd.

6. Parish boundaries. Again, parish boundaries often follow palaeochannels of the above types. There are a few cases where a parish boundary appears to provide the only evidence for a former water course.

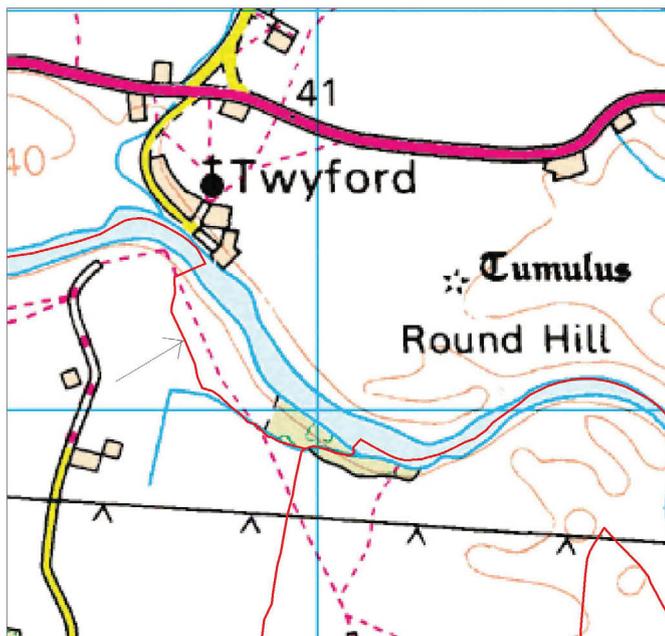


Figure 16: parish boundary (red line, arrowed), diverging from the main channel near Twyford, Derbys., suggesting a former channel course.

7. Ridge and swale topography, though not strictly a 'palaeochannel', has also been recorded. This topography is generally visible as irregular corrugations in the floodplain surface, or striated positive and negative cropmarks, usually parallel to the inside bank of a meander. It is caused by the formation of successive bars ('ridges') and intervening channels ('swales') during the process of meander formation, and can be taken as evidence for significant re-working of the associated sediments. However, swales may contain significant palaeo-environmental material, deposited for example through log-jams in slow-moving channels.



Figure 17: ridge and swale topography, Foremark, Derbys.  
Aerofilms 7145/11/959 (1971) © Simmons Aerofilms Ltd.

## Palaeochannel shapefiles

The above seven categories were adopted as the basis for the recording and classification of palaeochannels. Of the seven categories, numbers 1-4 were recorded as 'polygon' features (i.e. with both length and breadth); numbers 5-7 were recorded as linear features. The nature of the digitising process in ArcView requires that a shapefile must consist solely of features of the same type (point, line or polygon); it was therefore necessary to record palaeochannel features in more than one shapefile. In addition, it was decided to record ridge and swale (as a slightly different phenomenon) in a separate shapefile.

Palaeochannels (and ridge and swale) were therefore digitised and recorded in the following three shapefiles:

- palaeopoly.shp (polygon shapefile): all palaeochannel features of types 1-4 (polygon types);
- palaeoline.shp (polyline shapefile): all palaeochannel features of types 5 and 6 (linear types)
- ridgeline.shp (polyline shapefile): ridge and swale (type 7); the digitised lines within this shapefile represent visible *ridges*: consequently there may be several digitised lines within one area of ridge and swale.

## Questions of interpretation

A project of this sort creates a seemingly objective record. It is important to stress, however, that any process of interpreting aerial photographs is highly subjective without intensive ground validation. Many of the digitised palaeochannels are glaringly obvious from the air. However, other features raise questions of interpretation. Is a sinuous field boundary following a palaeochannel or simply skirting damp ground? Is a cropmark caused by a palaeochannel or by a random dip in the subsoil surface?

It seems sensible to avoid extreme responses to such problems. A minimal approach where only cast-iron palaeochannels are included runs a heavy risk of missing a wealth of potentially valuable information. An approach which includes absolutely everything runs the risk of creating such a mammoth database that it is impossible to sort the wheat from the chaff. It was decided, therefore, to adopt a middle way. Features have been included where interpretation as a palaeochannel appears to be the only, or the more likely alternative. Features have been rejected where an alternative interpretation (for example geology, ice-wedge polygons, ploughed-out field boundary) seems more likely.

Despite this approach, it is highly likely that some features within the database are not palaeochannels, and that some palaeochannel features have been excluded. The GIS database should be regarded therefore as a starting point for further evaluation, rather than as a finished and definitive record.

## Palaeochannel attributes

A number of text attributes were attached to each recorded feature within the GIS, as follows:

Attribute field	Example of value
Unique ID	1935
Type	3
Notes	Positive crop mark associated with sinuous field boundary
Notes 2	parish boundary (Elvaston/Draycott and Church Wilne)
NGR	SK48513735
Photosource 1	HSL UK 69 222_23_0917
Photosource 2	RAF 106G/UK/646_3120
Mapsource 1	OS 1" sheet 29 (1851); shown as active channel
Mapsource 2	
Borehole record	SK58NW/1-6
PalaeoPotential	Peat
Date Years BC/AD	250AD +/- 125
Date source	C14 Beta 12345
Comment	Investigated by TPAU (Howard 2005)

**Unique ID:** numbered from 1001 upwards; multiple ridges within the same area of ridge and swale are recorded under the *same* number (i.e. the unique ID refers to the *area* of ridge and swale rather than to individual ridge features).

**Type:** 1-7 as detailed above. Where types overlap (for example a cropmark followed by a field boundary), the lowest possible number is given (in this case 3: cropmark). Where more than one type occurs within the length of a feature (for example a depression which continues as a cropmark in a ploughed field), a decision will be made as to which type constitutes the majority of the feature. In both cases the additional information will be recorded in the *Notes* attribute.

**Notes:** additional descriptive information supplementing the *Type* category.

**Notes 2:** additional descriptive information, generally relating to parish boundary data.

**NGR:** an eight-figure National Grid reference given at a central point on the feature.

**Photosource 1:** the primary photograph on which the feature was identified and plotted.

**Photosource 2:** any other photograph which provided secondary information on the feature.

**Mapsource 1:** reference to any historic map on which the feature is shown; text description of how the feature is depicted (e.g. stream course, active channel, relict channel).

**Mapsource 2:** for use in future investigations

**Borehole record:** for use in future investigations

**PalaeoPotential:** for use in future investigations

**Date in years AD/BC:** for use in future investigations

**Date source:** for use in future investigations

**Comment:** for use in future investigations

### 3. THE PALAEOCHANNEL DATABASE

855 likely palaeochannel/ridge and swale features have been included in the GIS database. As described above, these are located in three separate shapefiles (data layers) within the GIS, due to the incompatibility of polygon and line data. The totals for the three shapefiles break down as follows:

Types 1-4 (polygon features in palaeopoly.shp)      658 features  
 Types 5-6 (linear features in palaeoline.shp)      163 features  
 Type 7 (areas of ridge and swale in ridgeline.shp)      34 areas (123 ridge features)

and further, by feature type:

Type	Description	Number
1	standing water	18
2	depression	241
3	crop-/soil-/moisture-mark	338
4	vegetation	61
5	field boundary/hedge-line	153
6	parish boundary	10
7	ridge and swale (areas)	34

#### Comparison of 1970s and 1940s coverage

The primary photo coverage was derived from aerial survey carried out 1969-1976, with some parts of North Lincolnshire supplemented with photographs from 1984 and 1989 (a total of 241 photographs). This initial phase of survey yielded 735 features.

Secondary photo coverage was derived from RAF survey carried out 1943-1948 (a total of 381 photographs). This phase of survey yielded an additional 127 features not visible in the 1970s coverage.

In addition, 10 probable palaeochannel features not visible in any photo coverage were identified using digital parish boundary data.

	1970s	1940s	parish data
<b>Types 1-4 (polygon)</b>	557	106	
<b>Types 5-6 (linear)</b>	142	11	10
<b>Type 7 (ridge and swale areas)</b>	31	3	

The 1940s coverage was particularly useful where ploughing had encroached onto the floodplain between the 1940s and 1970s, and also where urban development and road-building had obscured or destroyed palaeochannel features.



Figure 18: Sawley, Derby: 1946 photo (top) showing palaeochannel features and ridge and swale surviving in unploughed floodplain (arrowed), subsequently destroyed/obscured by ploughing and road building by 1971 (bottom). Bottom: © Simmons Aerofilms Ltd.

## Drift geology zones

The total project area of 438.4 km<sup>2</sup> comprises 262.6 km<sup>2</sup> of alluvial deposits (59.9%) and 155.6 km<sup>2</sup> of ‘floodplain terrace’ deposits (35.5%). The remaining 20.3 km<sup>2</sup> (4.6%) is due to small pockets of non-floodplain geology included within the project area for convenience, and also to some larger areas of gravel extraction represented in the BGS geological data.

Alluvium and gravel terrace were not distributed evenly across the five county areas within the project.

County	Total project (km <sup>2</sup> )	Alluvium (km <sup>2</sup> )	Floodplain terrace		Other		
			(%)	(km <sup>2</sup> )	(%)	(km <sup>2</sup> )	
North Lincs.	148.2	144.5	97.5	0	0	3.7	2.5
Lincs.	55.2	33.2	60.1	17.3	31.3	4.7	8.6
Derbys.	109.8	38.6	35.1	63.0	57.4	8.2	7.5
Leics.	17.3	3.4	19.7	11.7	67.6	2.2	12.7
Staffs.	107.8	42.8	39.7	63.6	59.0	1.4	1.3
<i>Notts. (for comparison)</i>	<i>239.0</i>	<i>142.5</i>	<i>59.6</i>	<i>81.1</i>	<i>33.9</i>	<i>15.4</i>	<i>6.5</i>
<b>Total</b>	<b>438.4</b>	<b>262.5</b>		<b>155.6</b>		<b>20.3</b>	



Figure 19: (left) southern project area: dynamic gravel terrace landscape (Trent/Derwent confluence, Derbys./Leics.) © Simmons Aerofilms Ltd.  
(right) northern project area: stable alluvial landscape (East Butterwick, North Lincs.)

The statistics bear out key differences between the northern project area (Lincolnshire and North Lincolnshire) and the southern area (Derbyshire, Leicestershire, Staffordshire). Towards the Humber confluence, a broader and apparently more settled channel is located in a predominantly alluvial landscape, with smaller areas of floodplain terrace in the Lincolnshire project area. In Derbyshire, Leicestershire and Staffordshire, a more dynamic river landscape is characterised by more extensive areas of floodplain gravel terrace, with correspondingly less alluvium.

### Comparison of palaeochannel areas by county

It was possible to calculate the area (km<sup>2</sup>) covered by mapped palaeochannel features in each county, and to break this down according to palaeochannel *Type*. This calculation is of course only relevant for those features in the GIS possessing area (i.e. for polygon features): hence only types 1-4 are represented in the following table.

Type	N. Lincs (km <sup>2</sup> )	(%)	Lincs. (km <sup>2</sup> )	(%)	Derbys. (km <sup>2</sup> )	(%)	Leics. (km <sup>2</sup> )	(%)	Staffs. (km <sup>2</sup> )	(%)	Total (km <sup>2</sup> )	(%)
1	0	0	0	0	0.15	5.2	0.17	10.3	0.13	4.3	0.45	5.2
2	0	0	0.04	5.0	0.95	33.0	0.51	31.3	0.75	25.4	2.26	26.1
3	0.30	100	0.79	90.3	1.31	45.4	0.91	55.9	1.77	59.7	5.09	58.7
4	0	0	0.04	4.7	0.47	16.3	0.04	2.5	0.31	10.5	0.87	10.0
<b>Total</b>	<b>0.3</b>		<b>0.88</b>		<b>2.89</b>		<b>1.63</b>		<b>2.96</b>		<b>8.66</b>	

Differing land-use profiles between the northern and southern project areas lead to differences in the representation of Types 1-4. In Lincolnshire and North Lincolnshire, with a large, stable channel and ploughing in most places right up to the river margins, palaeochannels are overwhelmingly recorded as Type 3 (crop-/soil-marks), with other types rare or absent. In Derbyshire, Leicestershire and Staffordshire, Type 3 is also the most common type. However, Types 1, 2 and 4 also occur in significant numbers. Type 1 (standing water) suggests relatively recently abandoned channels, and tends to occur close to the modern channel. Type 2 (depression) occurs most commonly on unploughed grassland on the floodplain.

	North Lincs.	Lincs.	Derbys.	Leics.	Staffs.	<i>Notts. (comparison)</i>
Palaeochannel area (km <sup>2</sup> )	0.30	0.88	2.89	1.63	2.96	9.30
% of project area in county	0.2	1.6	2.6	9.4	2.7	3.89

Calculation of the percentage of the project area in each county occupied by plotted palaeochannels again highlights differences between the northern and southern areas, with Derbyshire, Leicestershire and Staffordshire showing considerably higher percentage values. The exceptionally high value for Leicestershire is due to the small area of Trent floodplain in the county coinciding with the Derwent and Soar confluence areas which are particularly prolific in palaeochannels.

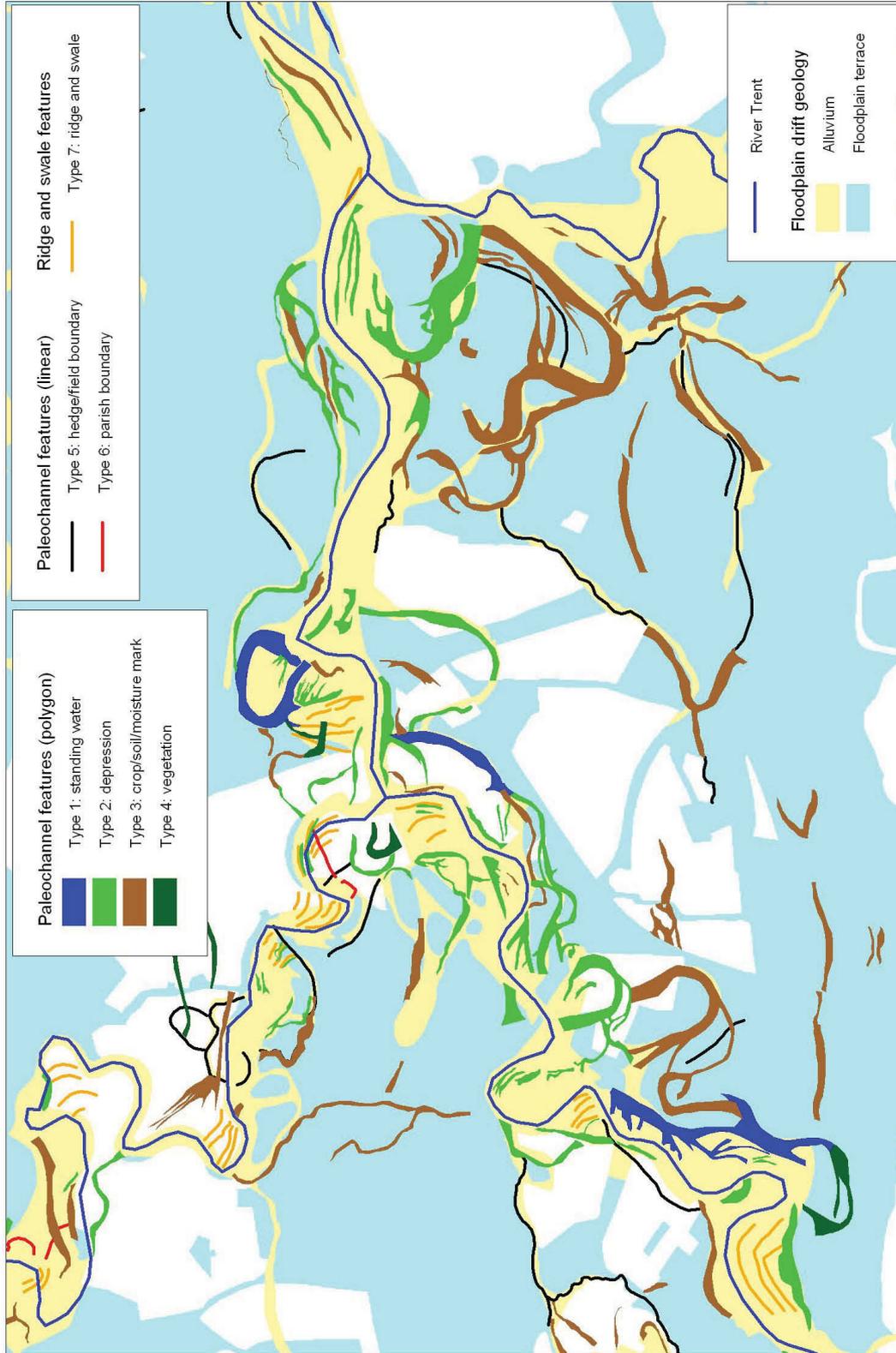


Figure 20: palaeochannel and ridge and swale features around the Trent/Derwent and Trent/Soar confluences, showing the distribution of Types 1-7

## Issues relating to preservation and destruction of features within the database

The palaeochannel features mapped during Component 2a were visible on aerial photographs taken during two main periods, with the primary coverage dating from 1969-1976, and the secondary coverage from 1943-1948. In order to use this data effectively within archaeological resource management (for example in the compilation of risk maps), it is highly desirable to assess the level of preservation of these features at the current time. It is clear that a proportion of the features within the database have been wholly, or partly destroyed, since the original photographic coverage, by gravel extraction, road-building, or other development.

To assess preservation issues accurately, we require an up-to-date dataset or datasets, relating to areas where drift geology has been removed. Unfortunately, at the moment, such a dataset does not exist for the entire project area. The British Geological Survey's 1:50000 DiGMap dataset, already acquired for drift geological coverage of the project area, contains information on 'artificial' areas – i.e. areas of worked-out or made ground, but only on map sheets where the survey date is relatively recent. The only 'artificial' dataset coinciding with the Component 2a project area is Sheet 131 Loughborough (surveyed in 2000), covering a large extent of the Derbyshire Trent Valley. The information is unfortunately absent for all other parts of the project area.

Within the Loughborough Sheet, it has been possible to generate ArcView shapefiles relating to areas of destroyed and surviving palaeochannel features, and to calculate the area, and percentage, of destroyed and surviving palaeochannels up to the year 2000.

	<b>Palaeochannels within Sheet 131</b>	<b>Surviving in 2000</b>	<b>Destroyed by 2000</b>
<b>Area (km<sup>2</sup>)</b>	4.46	3.87	0.59
<b>Percentage</b>	100%	86.8%	13.2%

It is clearly a future priority to generate, or acquire, data of this type for the whole project area.

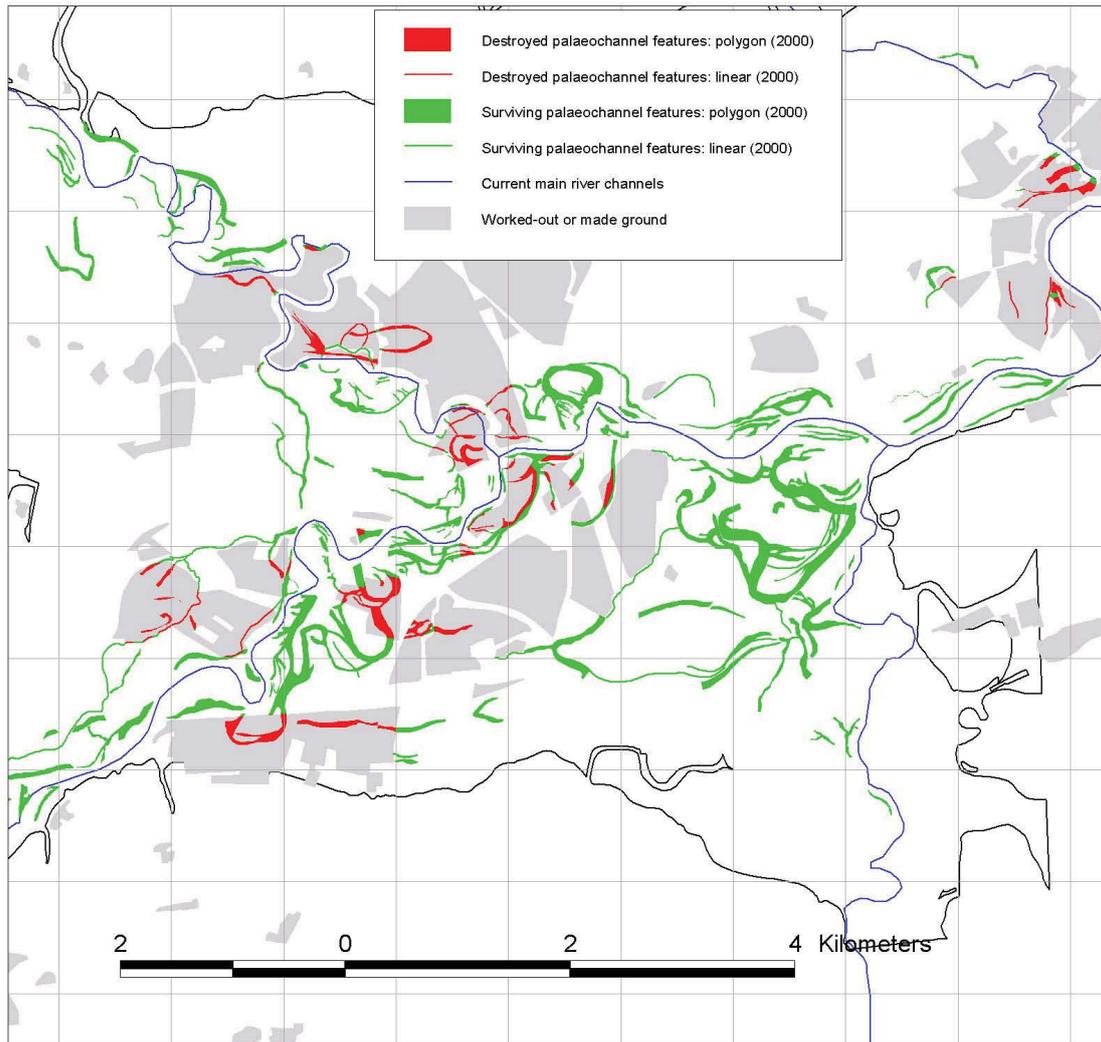


Figure 21: assessment of preservation/destruction of mapped palaeochannel features around the Soar and Derwent confluences, based on BGS survey carried out in 2000.

## 4. RECOMMENDATIONS

1. As discussed above, it would be desirable to generate data relating to the preservation or destruction of the palaeochannel resource, for the whole Trent Valley. This could be achieved using British Geological Survey datasets where available, supplemented by data held by county councils, recent aerial photographs, and detailed maps.
2. In some areas, in particular where gravel extraction has taken place, palaeochannels have been mapped through archaeological intervention on the ground. Comparison of the distribution of these channels with those mapped from aerial photographs would enable the relative merits of different methods of palaeochannel mapping to be assessed.
3. Extra fields should be added to the attribute data attached to palaeochannels, to allow more detailed palaeoenvironmental information, resulting from previous or future field investigation, to be appended.
4. The earlier Nottinghamshire project (Challis *et al.* 1999) produced an ArcView shapefile of palaeochannels in Nottinghamshire, mapped, similarly, using 1970s and 1940s aerial photographs. The Nottinghamshire shapefile does not, however, include any attribute data. In order to achieve a standard, comparable palaeochannel dataset for the whole Trent Valley, the Nottinghamshire shapefile should be updated by the adding of attribute data to the mapped channels. This would involve analysis of the mapped channels against the already digitised aerial photographs within ArcView, resulting in the compilation of attribute data as defined above.
5. In order to enhance the accessibility and profile of the palaeochannel database, the construction of a searchable web-based palaeochannel resource should be funded. This would take the form of a map of the Trent Valley, where mapped palaeochannel features could be interrogated through clicking or through text-based searches.

## 5. THE ARCHIVE: USER'S GUIDE

### Archive contents

The archive is intended primarily for use with ArcView GIS. Data layers are included as ArcView shapefiles and grids, and rectified photo images in Imagine raster viewer format, which is compatible with ArcView when the 'IMAGINE Image Support' extension is used. ArcView shapefiles can be converted and used within MapInfo; the rectified photo images have also been converted into GeoTIFF format which is compatible with a wider range of applications, though these are not included within the main archive due to the large file size.

The archive is located on six CD-ROM disks. Disk 1 contains the following directories:

- ArcView\_grids: contains ArcView grid datasets: a digital terrain model (DTM) giving continuous elevation values for the project area (in 25m squares); a drift geology grid (quicker loading than the corresponding shapefile).
- ArcView\_shapefiles: vector shapefiles: drift geology, county boundaries, project area definition, plotted palaeochannels and ridge-and-swale with attribute tables (3 shapefiles), 10 metre contours, River Trent, parish boundaries.
- Documentation: contains a digital copy of this document
- Historic\_maps: Ordnance Survey 1" 1<sup>st</sup> Edition maps (fluvial features surveyed in the 1820s and 1830s), scanned and digitised in ArcView grid format.
- OS\_base\_maps: Ordnance Survey 1:50000 digital raster images in 20km squares, stored in GeoTIFF format.

Disks 2-6 contain aerial photography images:

Disk 2: Lincolnshire    Disk 3: North Lincolnshire    Disk 4: Derbyshire

Disk 5: Staffordshire/Leicestershire    Disk 6: RAF 1940s photos

These directories contain raw scans and rectified images of all photographs used within the project. The scans are included for information only and cannot be loaded into ArcView.

The archive does not contain a ready-made ArcView project file (.apr format). Such files are sensitive to the set-up of ArcView on a particular computer (in terms of extensions loaded etc.) and to the folder location of the constituent shapefiles on individual computers, and are therefore not portable enough for inclusion in an archive of this sort. In order to use the archive, therefore, it is necessary to set up a project within ArcView, and import the required information into the project.

Full archive disks are to be stored in the following locations:

- Trent and Peak Archaeological Unit;
- Nottinghamshire County Council
- The Archaeological Data Service (ADS), to whom inquiries should be addressed in the first instance.

## Using the archive within ArcView

These instructions are intended to help a user of the archive to load and view the required information within ArcView, and to perform some basic manipulations. For more advanced topics, please use the ArcView 'help' facility, or consult your ArcView documentation.

### Setting up a project within ArcView

1. save the archive to a location on your computer's hard drive (it is not advisable to ask ArcView to read the data from the CD-drive)
2. double-click on the ArcView icon on the desktop
3. at the 'Welcome to ArcView GIS' dialog, select 'Create a new project as a blank project' and click OK
4. click on the 'File' menu at top left; select 'Extensions' and scroll down to 'IMAGINE Image support' and 'TIFF 6.0 Image Support'; ensure the relevant boxes are ticked and click OK.
5. highlight 'View' and click 'New'. This creates a View into which you can now introduce data.

### Loading shapefiles into a View

1. in your View, click the 'Add themes' button (marked with a plus sign)
2. in the 'Add theme' dialog, ensure 'Data Source Types' is set to 'Feature Data Source'
3. use the browser to navigate to the directory where you have saved the shapefiles
4. select the required shapefile (multiple files can be selected by holding down 'Shift' while selecting) and click OK. The shapefile(s) should now be displayed on the left-hand side of your view, and can be turned on and off by ticking its box.

Shapefile names are largely transparent. If clarification is required, see the Arcview\_shapefiles\_contents.txt metadata files in the shapefiles directory.

### Loading grids into a view (ArcView grids or historic maps)

1. in your View, click the 'Add themes' button (marked with a plus sign)
2. in the 'Add theme' dialog box, ensure 'Data Source Types' is set to 'Grid Data Source'
3. use the browser to navigate to the directory where you have saved the grids
4. select the required grid and click OK. The grid should now be displayed on the left hand side of your view, and can be turned on and off by ticking its box.

Grid names are largely transparent. If clarification is required, see the Arcview\_grids\_contents.txt metadata files in the grids directory.

### **Loading images into a view (rectified images or OS base maps)**

1. in your view, click the 'Add themes' button (marked with a plus sign)
2. in the 'Add theme' dialog box, ensure 'Data Source Type' is set to 'Image data source'
3. use the browser to navigate to the directory where you have saved the images
4. two or three files will appear for each image name; this is because ArcView accesses geo-referencing data for an image from an additional file with the same name. For rectified photos, you need to select the file with the .img filetype; for OS base maps, you need to select the file with the .tif filetype. Multiple images can be selected by holding down 'Shift' while selecting (this is particularly useful when loading large numbers of aerial photos). Click OK. The selected images should now be displayed on the left hand side of your view, and can be turned on and off by ticking their boxes.

### **Removing borders on images**

1. rectified photos will initially be displayed with a border (usually black but occasionally white). To remove the border, it is necessary to set the border colour to transparent (so that base map layers/other photographs) can be seen through it.
2. To do this, double-click on the image name to the left of your view. In the 'Image legend editor' dialog, click 'Colourmap'
3. In the 'Image colourmap' dialog, double-click on '0' (zero)
4. In the 'Colour palette' dialog, set to transparent (a white box at top left with an 'X')
5. click 'Apply' and close any open dialogs

### **Changing the order in which themes are displayed**

1. themes (layers in ArcView, whether images, grids or shapefiles) are displayed in the order in which they are shown on the left hand side of the screen. The theme at the top is shown on top, the theme at the bottom is shown at the bottom.
2. to change the order of display (for example in order to put a palaeochannel theme on top of a rectified aerial photograph), click on a theme name on the left-hand side of the screen, and drag it to its new position in the stack.

### **Viewing theme attributes**

1. some themes (particularly the three palaeochannel themes) have text data attributes attached in a theme table. There are two ways of viewing this information.
2. 'select' the theme whose table you wish to see, by clicking on its name on the left-hand side of the View
3. In the 'Theme' drop-down menu at the top of the screen, click on 'Table'; the theme table will now open

4. Alternatively, attribute data for individual features can be consulted as follows: 'select' the theme whose data you wish to see, by clicking on its name on the left-hand side of the View
5. click the 'Identify' button, on the left just above the View, marked with an 'i'
6. click on the feature whose data you wish to see. Its attributes will now be visible in a small box

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The author is grateful to Simmons Aerofilms Ltd., for their kind permission to reproduce copyright material (1971 photographs of the Derbyshire Trent Valley).

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Challis, K., Dingwall, L., Gaffney, V. and Howard, A.J. 1999: *Trent Valley Survey: Nottinghamshire Pilot Study*: Report to English Heritage by TPAU, BUFAU and University of Leeds

Challis K. 2002: *Trent Valley 2002 Component 2: Palaeochannel mapping and LiDAR terrain models*: Project design for Trent Valley Geoarchaeology

Malone, S. 1998: *Geomorphology from aerial photography*: Report for Nottinghamshire County Council by TPAU

## APPENDIX: KEY TO PHOTO SORTIES

### 1970s photographs

Derbyshire:	Aerofilms sortie 7145 © Simmons Aerofilms Ltd.	<b>1971</b>
Leicestershire:	Huntsman Surveys Ltd. sortie HSL UK 69 © Leics. County Council	<b>1969</b>
Staffordshire	Meridian Airmaps sorties 115/71, 133/71, 134/71 © Staffs. County Council	<b>1971</b>
Lincolnshire	Huntsman Surveys Ltd. sortie HSL UK 71 © Lincs. County Council	<b>1971</b>
North Lincolnshire	Meridian Airmaps sorties 36/76, 37/76, C9/76 © East Riding Council	<b>1976</b>
	AMSL sortie RC8 © North Lincs. Council	<b>1984</b>
	Jasair (various sorties) © North Lincs. Council	<b>1989</b>

### 1940s photographs

All sorties are © Crown Copyright English Heritage

#### Northern area (Lincolnshire and North Lincolnshire)

RAF/CPE/UK/2009	<b>1947</b>
RAF/CPE/UK/2012	<b>1947</b>
RAF/CPE/UK/2042	<b>1947</b>
RAF/CPE/UK/2043	<b>1947</b>
RAF/541/170	<b>1948</b>
RAF/CPE/UK/2563	<b>1948</b>

#### Southern area (Derbyshire, Leicestershire, Staffordshire)

RAF/16/AC637	<b>1943</b>
RAF/106G/UK/581	<b>1945</b>
RAF/106G/UK/646	<b>1945</b>
RAF/106G/UK/721	<b>1945</b>
RAF/106G/UK/734	<b>1945</b>
RAF/CPE/UK/1865	<b>1946</b>
RAF/541/28	<b>1948</b>
RAF/541/212	<b>1948</b>
RAF/CPE/UK/2469	<b>1948</b>
RAF/CPE/UK/2555	<b>1948</b>