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Geology of the Bicester area

1:10 000 Sheet **SP 52 SE**
Part of 1:50 000 Sheet 219 (Buckingham)

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1 INTRODUCTION

This report describes the geology of 1:10 000 Geological Sheet SP 52 SE (the Bicester area), and is best read in conjunction with that map.

Until recently, the only medium-scale published geological map of the district around Bicester was the Geological Survey Old Series One-Inch (1:63 360-scale) Sheet 45 SE, which was surveyed during the 1850s and `60s by E Hull, H Bauerman, W Whitaker and T R Polwhele, and published in 1863, and described by Green (1864). By today's standards, this is little better than a sketch map of the geology, and is both incomplete and incorrect in many respects. It is entirely superseded by Sheet SP 52 SE, the subject of this report, which was surveyed at the 1:10 000-scale by M G Sumbler during the spring of 1999. This work was carried out as part of the survey of BGS 1:50 000 Geological Sheet 219 (Buckingham), which was completed in May 2000. It is anticipated that this map will be published later in 2001.

The survey of the area involved the collection of new data on the ground, but use was also made of earlier geological maps, records of boreholes and wells, and commercially available aerial photography. The resulting map includes some important revisions to the earlier versions, notably in the accurate depiction of boundaries, revision of the stratigraphical classification of the rocks, and the delineation of drift deposits. This report is based mainly on this latest work, but also incorporates data from other sources where appropriate, as indicated herein (see References and Information Sources). Abbreviated logs of important wells and boreholes that prove the stratigraphy of the area are given in Appendix 1.

As may be inferred from the name, Bicester has Roman connections, but the precise origins of the name are unclear. Whilst it might be deduced to mean 'two roman towns' - it lies on a roman road, and there are remains of another Roman settlement nearby at Alchester (on the southern margin of the map) at the crossing point with another Roman road - in the Domesday Book the town is 'Bernecestre', i.e. 'the fort of the warriors' or of 'Beorna', perhaps a local chieftain.

In later times Bicester became an important market town and hunting venue. It was also a staging post on the main route from the Midlands to London and maintained its importance when the construction of the London and North-western Railway and later the Great Central Railway led to considerable expansion. In the twentieth century, a long association with the military began with the construction of RAF Bicester aerodrome on the north-eastern outskirts and later the Ordnance depot at Graven Hill. More recently there has been a certain amount of light industrial development mainly on the eastern side of the town, retail development, notably 'Bicester Village' to the south, and large areas of residential estates, which are continuing to expand.

Notes:
Both this report and the corresponding map (Geological Sheet SP 52 SE) should be regarded as provisional documents pending publication of the new version of Sheet 219; in particular, certain geological concepts and lithostratigraphical names may be subject to future revision. Sheet SP 52 SE indicates the outcrop limits of deposits which are mostly concealed beneath soil and vegetation; the geological boundary lines are inferred from indirect evidence such as the form of the ground surface and soil type, or are extrapolated from adjoining ground. It is

thus the subjective interpretation of the surveyor, and all geological boundaries carry an element of uncertainty. Boundaries of solid geological formations which, in the opinion of the surveyor, can be located to an accuracy of about 10 m or less on the ground, are shown as unbroken lines; all others are shown broken.

Copies of the 1:10 000 map can be purchased from BGS, Keyworth, where records of boreholes and other data may also be consulted by prior arrangement. Copyright restrictions apply to the use of both the map and this report, and to the copying of the material thereof. The map and report are internal publications of the BGS and any information extracted from them should be acknowledged by the appropriate bibliographical reference.

Equivalent technical reports covering the equivalent 1:10 000 sheet to the south is available; reports for the other adjoining sheets may appear in due course:

SP 52 NE (Stoke Lyne) (pending)
SP 62 SW (Marsh Gibbon) (pending)
SP 51 NE (Charlton-on-Otmoor) Ambrose 1988
SP 52 SW (Middleton Stoney) (pending)

The BGS memoirs for the adjoining 1:50 000 Sheets 218 (Chipping Norton) and 237 (Thame) also give much pertinent background information regarding the stratigraphy (Horton et al., 1987; 1995) as will the Sheet explanation for 1:50 000 Sheet 219 (Buckingham; in prep.).

Throughout this report National Grid References are given in square brackets; all lie within 100 km grid square SP (or 42) unless otherwise stated.

QUATERNARY:	
ALLUVIUM	up to 2.5
RIVER TERRACE DEPOSITS	up to 3
MIDDLE AND UPPER JURASSIC:	
ANCHOLME GROUP:	
Oxford Clay Formation	62+
Weymouth Member	15+
Stewartby Member	21
Peterborough Member	26
Kellaways Formation	5 to 6
Kellaways Sand Member	2 to 3
Kellaways Clay Member	3 to 4
GREAT OOLITE and INFERIOR OOLITE GROUPS:	
Cornbrash Formation	3
Forest Marble Formation	3 to 5
White Limestone Formation	12 to 18 (typically 14)
Bladon Member	0 to 3
Ardley Member	8 to 10
Shipton Member	1 to 6
Rutland Formation	7 to 10.5
Taynton Limestone	2 to 7
Sharp's Hill Formation	2 to 3.5
Horsehay Sand Formation	3 to 4
Northampton Sand Formation	? up to 2.5
LOWER JURASSIC	
LIAS GROUP:	
Whitby Mudstone Formation	5 to 16
Marlstone Rock Formation	1 to 2
Dyrham Formation	9
Charmouth Mudstone	65 to 85
TRIASSIC	
PENARTH GROUP	0 to 5
MERCIA MUDSTONE GROUP	0 to 15
BROMSGROVE SANDSTONE FORMATION	0 to 15
CARBONIFEROUS	
Arenaceous Coal Formation	0 to c. 100
DEVONIAN	
UPPER OLD RED SANDSTONE	172.5 (in Bicester Borehole)
SILURIAN	
Sandstones	44.5 (in Bicester Borehole)
Volcanic rocks	128.3 (in Bicester Borehole)

Table 1. Geological sequence proved within SP 52 SE (Bicester), giving estimated thicknesses in metres.

2 CONCEALED FORMATIONS

2.1 Silurian

The oldest rocks proved within the Bicester area are Silurian strata penetrated in the Bicester No 1 Borehole [5878 2081], which was drilled for hydrocarbon prospecting by Shell Exploration in 1976. The beds are assumed to overlie Tremadoc (Ordovician) strata which are known from other boreholes in the region, such as the Marsh Gibbon Borehole [6481 2374] some 6 km to the north-east where they are overlain directly by Lower Jurassic rocks.

In the Bicester Borehole, 128.3 m of highly altered basaltic and andesitic lavas and tuffs were penetrated between 385.6 m depth and the bottom of the borehole at 513.9 m. Though not proven, an early Silurian age has been inferred for these rocks (Pharaoh et al., 1991). In the borehole, the volcanics are succeeded by 44.5 m of interbedded sandstone and mudstone (top at 341.1 m depth). These are probably shallow marine strata of Upper Llandovery age.

2.2 Devonian

Devonian strata including both shallow marine and continental (Old Red Sandstone) facies are widespread in the region. 172.5 m of such strata were proved in the Bicester Borehole between the base of the Triassic at 168.6 m depth and the top of the Silurian sediments at 341.1 m. The succession was dominated by horizontally-bedded purplish brown mudstones and greenish grey fine-grained sandstones, but also included minor units of marine limestone. These strata are probably approximately correlative with those proved in the Northbrook Borehole [4995 2246], some 10 km to the west-north-west, and in the Noke Hill Borehole [5386 1285] 9 km to the south-south-west. The latter boreholes beds yielded fish and lingulid fossils which suggest an Upper Devonian (Famennian) age (Butler, 1981).

2.3 Carboniferous

No Carboniferous rocks were present in the Bicester Borehole, but it is likely that they occur at depth in the western or north-western part of the area which is known to lie close to the eastern margin of the north - south trending Oxfordshire Coalfield Syncline, in which Carboniferous rocks are preserved beneath the Mesozoic cover (see Horton et al., 1995, fig. 3). Whilst early Carboniferous rocks occur in the centre of the syncline in Berkshire and South Oxfordshire, they are overlain unconformably by younger Carboniferous strata which overlap them to rest directly on the underlying Devonian strata farther north and at the margins of the syncline (Foster et al., 1989). Thus, in north Oxfordshire, the Carboniferous succession of the coalfield is represented principally by late Bolsovian (Westphalian C) and Westphalian D strata. These comprise the Arenaceous Coal Formation and succeeding strata formerly classified as the Witney Coal, Crawley, Burford Coal and Windrush formations (Poole, 1969; 1978). These latter beds have been shown to equate with the Halesowen Formation of the West Midlands (Peace and Besley, 1997). Both the Arenaceous Coal Formation and 'Halesowen Formation' were formerly included in the Upper Coal Measures but the latter (at least) is now classified as part of the Warwickshire Group (Powell et al., 2000). Whilst nearly 1 km thick in the centre of the syncline (Poole, 1969), the sequence thins eastwards (Foster et al., 1989), as a result of the erosion that followed late Variscan folding so that only the basal member of the succession, i.e.

the Arenaceous Coal Formation, comprising grey sandstones with minor mudstones, seatearths and coals, is likely to be present in the Bicester district. Over 200m of these strata have been proved by British Coal exploratory boreholes some 3 km west of the Bicester area. Assuming uniform eastward thinning, it is possible that 50 m to 100m of Carboniferous strata may be present at the western margin of the Bicester area, at a depth typically of about 160 m below the surface.

2.4 Triassic

In late Carboniferous and Permian times the region was uplifted to form the London Platform, which remained a stable, structural high throughout the Mesozoic. Some 25 km to the west, the subsiding Worcester Basin was gradually infilled with Permo-Triassic sediments, mainly of terrestrial facies, but this succession thins rapidly eastwards onto the London Platform, by a process of progressive overlap combined with condensation.

2.4.1 Sherwood Sandstone Group

No Permian or Early Triassic rocks are known on the London Platform but it is probable that the feather-edge of the Sherwood Sandstone Group is present at depth within the north-western part of the Bicester area. Only the Bromsgrove Sandstone Formation, the youngest part of the group, and dominantly of fluvial origin, is likely to be present, as proved in boreholes to the north-west (Horton et al., 1987). Probably up to about 10 to 15 m of Bromsgrove Sandstone Formation may be occur within the area (see Horton et al., 1987, fig. 7); the GCN116 Borehole [5380 2350] at Middleton Stoney, 1.2 km beyond the western margin of the area proved c. 13m of brown fine to medium grained more or less argillaceous sandstone and siltstone, with some quartz pebbles. The formation was not present in the Bicester Borehole, presumably being overlapped by the younger Mercia Mudstone Group some distance to the north-west.

2.4.2 Mercia Mudstone Group

Some 13 m of Mercia Mudstone were proved in the GCN116 Borehole, so it is probable that 10 to 15 m of Mercia Mudstone is present in the north-west of the Bicester area (see Horton et al., 1987, fig. 8). South-eastwards, it is believed to overlap the Bromsgrove Sandstone to rest on Devonian strata. In the Bicester Borehole [5872 2081], the Mercia Mudstone Group is believed to be represented by 6.1 m of smooth, reddish brown mudstone with greenish grey mottles proved between c. 162.5 and 168.6 m depth . It is probably overstepped by the Penarth Group to the south-east. The Mercia Mudstone Group accumulated in playa lakes in a desert environment.

2.4.3 Penarth Group

The Penarth Group is a thin succession of marine strata that forms the youngest (Rhaetian) part of the Triassic. Where complete, it comprises the Westbury Formation and succeeding Lilstock Formation, the latter including the limestone-dominant Langport Member ('White Lias' at the top). In the GCN116 borehole, some 6.1 m of mudstones succeeded by limestone may represent an essentially complete succession. It is likely that the Westbury Formation and lower part of the Lilstock Formation is overlapped eastwards such that in the (uncored) Bicester Borehole only the Langport Member, represented by a marked peak on the gamma ray log, between 161.5 and 162.4 m depth, appears to be present. This in turn may be cut out beneath the Lias in the south-eastern corner of the area.

According to Horton et al. (1987 fig. 11), the Penarth Group within the Bicester area is represented mainly by 'Twyford Beds', a marginal facies of siltstones and locally conglomeratic sandstones that were originally proved by boreholes some 8 km east of the area (Donovan et al, 1979) and are believed to equate essentially with the Lilstock Formation (Horton et al., 1987). This may be correct, although the control on the distribution of the Twyford Beds is very poor. Moreover, there is no biostratigraphical confirmation that they belong to the Penarth Group (Rhaetian), even at their type section ; it seems just as likely that, in some cases at least, they represent the basal part of the Lias Group, which is locally of Upper Sinemurian to Pliensbachian age (see below).

2.5 Lower Jurassic: Lias Group

The mainly mudstone succession of the Lias has traditionally been divided into Lower, Middle and Upper Lias. These ill-defined units are now replaced by lithostratigraphical formations, as defined by Cox, Sumbler and Ivimey-Cook (1999).

2.5.1 Charmouth Mudstone Formation

The Charmouth Mudstone, corresponding approximately with the Lower Lias of previous accounts, is dominated by grey mudstones with sporadic argillaceous limestone nodules. In the Bicester area, the succession is much thinner than in areas farther west (Horton et al., 1987, fig. 15) and only the upper part of the succession (mostly Pliensbachian) is present; this relates to progressive south-eastward onlap of the strata onto the London Platform, as described by Donovan et al. (1979).

On the basis of the gamma ray log of the Bicester Borehole, the Charmouth Mudstone there is judged to be 69.8 m thick (91.7 to 161.5 m depth). Leftward (low) gamma ray peaks are interpreted as calcareous mudstone or argillaceous limestone beds; these include the geophysical markers described by Horton and Poole (1977). By comparison with the logs of the GCN116 Borehole, the so-called 85 Marker (within the Ibex Zone) occurs between 124.4 and 127.7 m depth, and the 70 Marker (within the Jamesoni Zone) occurs between 147.5 and 150.6 m depth, only 10.9 m above the base of the Lias. The beds below the 70 Marker have a 'spiky' gamma ray signature, suggesting interbedded limestones and mudstones. These limestone-rich beds are widespread at the base of the Lias in the region, constituting a diachronous shallow-water or littoral facies. By comparison with other boreholes in the region, at Bicester it is inferred that they are unlikely to be older than the Raricostatum Zone.

The Charmouth Mudstone thickens somewhat to the north-west, being c. 81 m thick in the GCN 116 Borehole, and on this basis it is deduced that it probably ranges from c. 65 m to c. 85 m within the Bicester area.

2.5.2 Dyrham Formation

The Dyrham Formation, corresponding approximately with the Middle Lias Silts and Clays of previous accounts, comprises grey, silty and finely sandy, commonly micaceous mudstones. From the gamma ray log, on which it is manifested by generally lower counts than the underlying Charmouth Mudstone, it is estimated to be 8.8 m thick in the Bicester Borehole (82.9 to 91.7 m depth). The log is closely similar to that of the GCN 116 Borehole in which the formation is c. 9 m thick.

2.5.3 Marlstone Rock Formation

The Marlstone Rock, comprising ferruginous limestone and sandstone, is thought to be c. 1.5 m thick in the Bicester Borehole (81.4 to 82.9 m depth), although this thin bed cannot be accurately resolved because of the small scale and low resolution of the gamma ray log. This compares with c. 2.1 m in the GCN 116 Borehole. The Marlstone Rock Formation is recorded at 53.6 m depth in the Lord's Farm Well (SP 52 SE/9 [5746 2424]; see Appendix 1), being described as 0.91 m of 'hard grey rock' succeeded by 0.30 m of 'marlstone'.

4 2.5.2 Whitby Mudstone Formation

The Whitby Mudstone, i.e. the Upper Lias of previous accounts, is dominated by dark grey silty and finely micaceous mudstones. From the gamma ray log it is thought to be c. 8.8 m thick in the Bicester Borehole and c. 15.2 m in the GCN 116 Borehole, suggesting a range of about 5 to 15 m within the Bicester area, although it is a little thicker (16 m) in the Lord's Farm Well (see Appendix 1).

2.6 Middle Jurassic: Inferior Oolite Group and Great Oolite Group

The Inferior Oolite Group and Great Oolite Group are dominated by limestones and sands with subordinate marls and mudstones, by contrast with the underlying Lias Group and succeeding Ancholme Group, both of which are overwhelmingly represented by mudstone. The lower part of the Oolite succession is known only from the logs of wells and boreholes for which the data is very limited, such that on the basis of these alone it is not possible to reliably subdivide the succession into its constituent formations. However, Ardley Railway Cutting [513 291 to 559 250], a few kilometres to the north-west of the area provides a section through these strata that has been described in some detail (Arkell et al., 1933; Horton et al., 1987; Cox and Sumbler, in press), and provides a relevant reference section. The succession there is as follows:

Cornbrash Formation	c. 3 m
Forest Marble Formation	up to 5.56 m
White Limestone Formation	up to c. 13 m
Rutland Formation	8.43 m
Taynton Limestone Formation	5.03 m
Sharp's Hill Formation	1.37 m
Horsehay Sand Formation	3.35 m (typically)
Northampton Sand Formation	up to 5.94 m

The total thickness of this succession, c. 45 m, is only slightly greater than the 38 to 42 m proved in this area, of which the 41.76 m based on the gamma ray log of the Bicester No 1 Borehole is probably the most reliable figure (Appendix 1).

2.6.1 Northampton Sand Formation

The basal beds present in the Ardley Cutting comprise grey and brown argillaceous and ferruginous sandstone, originally assigned by Arkell et al (1933) to the 'Hook Norton Beds' (i.e. Chipping Norton Limestone Formation, the basal unit of the Great Oolite Group) but now regarded as Northampton Sand Formation, which is of Aalenian age, and part of the Inferior Oolite Group. This unit cannot generally be distinguished from the overlying sandy beds in well and borehole logs, but it is possible that 0.91 m of 'dark sandstone' recorded in the Bicester Town No 2 well (SP 52 SE/29 [5715 2388]), and 0.30 m of 'dark brown rock' in the Laundry No 2 Well (SP 52 SE/7 [5854 2361]) may represent this unit (Appendix 1). Similarly, a strong leftward (low gamma) peak immediately above the Whitby Mudstone in the Bicester No 1 borehole may represent the Northampton Sand Formation, judged to be 2.44 m thick.

2.6.2 Horsehay Sand Formation

Many of the water wells in the Bicester area terminate in sandy beds below the Taynton Limestone. There appear to be about 6 to 7 m of these strata above the presumed Northampton Sand Formation (where present). The lower part, perhaps typically 3 to 4 m thick is thought to belong to the Horsehay Sand Formation (new name) which in the Ardley Cutting comprise white to yellow and black, mostly unconsolidated sands, that rest sharply on the Northampton Sand and locally channel deeply into it.

The Horsehay Sand Formation comprises the strata traditionally known as the 'White Sands' or 'Swerford Beds' in this region. Their age and status is somewhat controversial. Whilst originally they had generally been thought to be equivalent to part of the Chipping Norton Limestone, i.e. Great Oolite Group (e.g. Arkell et al., 1933), according to Horton (1977) they are Aalenian strata equivalent to the Grantham Formation (formerly Lower Estuarine Series) of the East Midlands to which they are lithologically closely similar, i.e. part of the Inferior Oolite Group (see also Horton et al., 1987).

However, the case for the original view is very persuasive, as discussed by Bradshaw (1978). He argued that any supposed Lower Estuarine Series or Grantham Formation south of (approximately) the Peterborough area actually represents the fluviatile and lacustrine Stamford Member of the Rutland Formation (Bathonian), and that the 'White Sands' is a facies transitional between the non-marine Stamford Member and the fully marine Chipping Norton Limestone to the west; the beds are believed to have been formed in a brackish coastal marsh environment. This is the view accepted here, and is supported by the presence of late Bajocian and early Bathonian dinoflagellate cysts from the 'White Sands' as described by Fenton et al (1994), although this palynological evidence is not fully conclusive because of the possibility of sample contamination; indeed it is surprising to find any indigenous dinoflagellates given the supposed brackish environment of deposition and the generally oxidized condition of the sediments.

2.6.3 Sharp's Hill Formation

In Ardley Cutting, the Sharp's Hill Formation comprises c. 1.4 m of grey clays and marls with subordinate limestone, and including a highly carbonaceous bed, named the 'Peat Bed' by Arkell et al., 1933). Similar lithologies, including 'peat', clay and sand recorded beneath the Taynton Limestone in the Bicester Town Well (SP 52 SE/5 [5709 2384]; Appendix 1) probably represent the Sharp's Hill Formation. In the Bicester No 1 borehole, up to about 3.35 m of mainly mudstone strata at this level, inferred from the gamma ray log, likewise probably belong to the formation. Whilst it cannot be distinguished unequivocally from the Horsehay Sand Formation in records of other wells or boreholes in the area, it has been recorded in adjoining areas (see Horton et al., 1995) and is thus in all probability present throughout the Bicester area. Comparing other sections in the region, the inferred thickness of the Sharp's Hill Formation in the Bicester Borehole is somewhat greater than might be expected; perhaps 2 m is a likely average for the area.

2.6.4 Taynton Limestone Formation

The Taynton Limestone typically consists of cross-bedded, shell fragmental, ooidal limestones (grainstones) with subordinate finer-grained (packstones), marls and clays. It is represented by 'hard grey rock' or 'grey stone' recorded in most of the wells of the area; it is commonly noted as water-bearing. Recorded thicknesses range from 2.13 m up to 7.01 m. The latter figure, based on the gamma log of the Bicester No 1 borehole, is unusually large, and about 5 m is a likely average for the area.

2.6.5 Rutland Formation

The Rutland Formation is dominated by marls and clays, with subordinate limestones. The dominance of these argillaceous rocks permits its recognition in the rather rudimentary logs of wells and boreholes, and on the gamma log of the Bicester No 1 Borehole. These records suggest that its thickness lies within the range 7 to 10.5 m within the Bicester area. A comparable thickness (8.43 m) was proved in Ardley Cutting, but the formation apparently thins towards the south, being only 4.1 m thick in the M40 Borehole 231 [5715 1718] (Horton et al., 1995). More local thickness variation in the area is probably due largely to the essentially gradational and interdigitating relationship with the succeeding Shipton Member of the White Limestone.

The Rutland Formation in the Bicester region comprises only the upper part of the type succession of the East Midlands, lower parts being represented by underlying units of the Great Oolite (i.e. Taynton Limestone, Sharp's Hill Formation and Horsehay Sand formations, Bradshaw, 1978). Its most characteristic feature is its cyclic nature; locally, two main regressive rhythms are believed to be present. Where fully developed, each rhythm consists of marine mudstones, marls or limestones at the base and a non-marine rootlet bed at the top, which is truncated by the marine unit of the succeeding rhythm. The basal part of the lower of these two rhythms is the Taynton Limestone Formation (see above).

In previous accounts of this region the deposits have been referred to the Hampen [Marly] Formation (e.g. Arkell et al., 1933; Palmer 1979) but this unit is of substantially different facies in its type area, being dominated by fully marine calcarenitic limestones (Sumbler and Barron, 1996). The westward limit of the Rutland Formation and its passage into Hampen Formation is taken arbitrarily a few kilometres west of the Bicester area (see Horton et al., 1995, fig. 8).

2.6.6 White Limestone Formation

The White Limestone has been penetrated by a number of wells and boreholes in the area (Appendix 2) from which it is deduced to be from about 12 to 18 m in thickness, averaging about 14 m. Whilst there is probably a slight overall thinning towards the south-east, the majority of this variation is due to the arbitrary and gradational base of the formation and to a lesser extent the irregularly channelled top of the formation.

The formation is dominated by white, cream and buff limestones (wackestones), with varying proportions of peloids (mainly faecal pellets) and shell debris set in a micrite matrix. Beds of grey marly limestones and mudstones occur at certain levels, but higher energy packstones and grainstones are rare.

The formation is divisible into Shipton, Ardley and Bladon members in ascending order (Sumbler, 1984, amending Palmer, 1979); this subdivision is based essentially on the recognition of various marker beds (notably at the junctions), some of which are characterised by, and named after, particular fossil gastropod species (notably of *Aphanoptyxis*; Barker, 1976, 1994). These members can be identified with more or less confidence from the records of the boreholes.

Generally, the Shipton Member is between 3 and 4 m thick, but some borehole logs suggest a greater thickness range, from perhaps as little as 1 m, up to about 6 m or more. It is made up of peloidal wackestones and packstones with beds of argillaceous limestone, marl and mudstone. The latter vary in abundance from place to place, and the boundary with the underlying Rutland Formation is one of lateral passage and interdigitation, such that the boundary in any one section is somewhat arbitrary, accounting for the bulk of the thickness variation mentioned. The top of the member is marked by the Excavata Bed, the upper part of which may be developed as a strongly cemented hardground (indicative of submarine lithification), capped by an erosion surface.

The succeeding Ardley Member ranges from about 8 to 10 m in thickness. It is made up very largely of peloidal wackestones although a bed of sandy mudstone or siltstone occurs at the base, resting on the Excavata Bed. This sandy mudstone, a readily recognised marker in boreholes (including gamma-ray logs), is succeeded by a sandy limestone known as the Roach Bed. The topmost bed of the member is known as the Bladonensis Bed, the top of which, in this area, is typically a weak grey wackestone which may show lamination, shrinkage cracks and clay-filled fissures or rootlets.

The Bladon Member, which forms the youngest part of the White Limestone, varies from (probably) zero up to about 3 m or more in thickness; 1.5 to 2 m is typical. The lower part, known as the Fimbriata-Waltoni Bed, is a green and grey to black mudstone which is commonly highly carbonaceous, often containing much lignite. In some cases, it also contains calcareous nodules including probable caliche, indicating emergence, and evidently represents a nearshore saltmarsh-type environment. The upper part of the Bladon Member is the so-called Upper Epithyris Bed, which is generally a more or less marly, commonly fossiliferous, wackestone. In places this bed is absent beneath the erosive, channelled base of the mudstone-dominated Forest Marble, in which case it may be difficult to recognise the junction between the two formations. Indeed in many older accounts, the Bladon Member was not recognised as such, and was included in the Forest Marble (see Sumbler 1984 for discussion). However, the generally lignitic nature of the Fimbriata-Waltoni Bed may help distinguish it from the otherwise rather similar mudstone of the Forest Marble.

3 MIDDLE JURASSIC: GREAT OOLITE GROUP

3.1 Forest Marble Formation

The Forest Marble is the oldest formation seen at the surface in the Bicester area, where it crops out in the stream valleys that cut through the Cornbrash. As proved by boreholes, it varies from about 3 to 5 m in thickness, most of this variation being a result of its erosive base which channels into the top of the underlying White Limestone Formation (see above; Sumbler, 1984). In the Bicester area, the succession is made up largely of of grey mudstone and greenish buff marl, but minor units of limestone occur sporadically in all parts of the succession. These are predominantly flaggy, shell-fragmental, ooidal, commonly somewhat sandy or argillaceous limestones with a predominantly fine-grained micritic (or micritised) matrix. The limestones, which for the most part are channel-filling bodies, tend to die out rapidly when traced laterally so that in detail, the succession varies greatly from place to place as described by Allen and Kaye (1973) in their description of the 'Kemble and Wychwood Beds' at Shipton-on-Cherwell Quarry [477 175], c. 8 km south west of the area.

The soils on the Forest Marble outcrop are dominated by brown and grey clays, and groundwater seepage from the overlying Cornbrash commonly makes them damp and muddy. There are many small ponds on the outcrop which in some cases may have been used for brick clay extraction; a more extensive probable brickpit, now incorporated into a flood relief reservoir, occurs near Bicester Airfield [590 242]. The Forest Marble may also have been worked in conjunction with the Cornbrash in some quarries.

No exposures were available during the survey of the area, but grey to buff clay with sporadic small oysters (*Praeexogyra hebridica*) and pieces of flaggy white to bluish grey shell fragmental oolite were amongst debris dug from newly constructed flood relief reservoirs in north Bicester [577 237; 581 235].

3.2 Cornbrash Formation

The outcrop of the Cornbrash dominates the geological map of the Bicester area, forming a broad, flat dip-slope which descends gently from 103 m OD in the NW to about 70 m in the south-east, where it dips beneath the Kellaways Formation. The Cornbrash re-emerges as a tiny outcrop in the extreme south-eastern corner of the map. This north-westward dipping outcrop lies on the north-west flank of the south-west to north-east trending Charlton Anticline, the axis of which runs a few hundred metres to the south-east.

The Cornbrash Formation consists of medium to fine-grained, shell-fragmental wackestones and packstones with rare peloids. The rock is characteristically intensely bioturbated and consequently poorly bedded. Whilst bluish grey when fresh, it weathers to an olive or yellowish brown colour and produces a characteristically unevenly platy brash in arable fields. It generally rests sharply (and erosively) on mudstone of the Forest Marble and this enables the base to be readily recognised in boreholes, in which the formation appears generally to be 2.7 to 3.2 in thickness. A few somewhat greater figures, e.g. the 3.96 m of 'limestone' recorded in the log of the Chesterton Well (SP 52 SE/ 2 [5572 2160]) may possibly include limestone which is actually part of the Forest Marble Formation.

The Cornbrash was formerly worked from many quarries within the area, probably mainly for road metal and lime burning, and also to some extent for dry walling. However, there are no records of any sections in the Bicester area, other than a brief allusion by Douglas and Arkell (1932, p. 27) to the Bicester Workhouse Quarry, now built over within the Highfield estate [probably 575 233, or possibly 577 235]. These authors suggested that the section at Stratton Audley Quarry [601 252], just to the north-east of the area, is typical for the Bicester area. In summary, the section there showed 2.36 m of hard grey limestone with a 0.53m bed of 'buff-marl' in the upper part. Orange or yellowish brown clay, sandy clay or clayey sand 0.25 to [rarely] 0.6 m thick, recorded in some of the many boreholes and trial pits for which records are held by BGS, may represent this bed. It appears, however, to be impersistent, since other records describe the succession as being composed entirely of limestone.

The fauna of the Cornbrash is dominated by brachiopods and bivalves, though fossils in general are not common in the Bicester area, as remarked upon by Douglas and Arkell (1932). The brachiopods and the rarer ammonites have been used to subdivide the formation into Lower and Upper parts belonging to the Bathonian and Callovian stages, respectively, of chronostratigraphy (Douglas and Arkell, 1932). Only Lower Cornbrash faunas have been recorded in the neighbourhood of Bicester (e.g. at Stratton Audley Quarry) but it is possible that thin Upper Cornbrash may occur locally (see for example Cox, Hopson and Sumbler, 1991).

4 MIDDLE AND UPPER JURASSIC: ANCHOLME GROUP

4.1 Kellaways Formation

The Kellaways Formation, about 5 to 6 m in thickness, comprises the Kellaways Clay and Kellaways Sand members, which have been mapped separately. On the early geological map of the area (Old Series One-inch Sheet 45 SE), the formation was included in the Oxford Clay.

4.1.1 Kellaways Clay Member

The outcrop of the Kellaways Clay forms a fairly narrow strip of dark greyish brown, heavy clay soils, at the foot of the brashy Cornbrash dipslope, between Little Chesterton and south Bicester, and underlies the valley of the Langford Brook just south of Bicester. A small outcrop also appears in the south-east corner of the map, on the flank of the Charlton Anticline.When fresh, the member is seen to consists of dark bluish to purplish grey, smooth-textured, slightly silty, fissile, somewhat pyritic mudstone. The top of the member, taken at the base of the first arenaceous bed of the Kellaways Sand, is necessarily somewhat arbitrary and imprecise, so the thickness of the unit as recorded in boreholes is rather variable. Mapping and other boreholes suggest that 3 to 4 m is typical. The minimum recorded thickness is c. 1.8 m in the Bicester Borehole, although this is based solely on interpretation of the gamma log.

The Kellaways Clay was formerly worked for brick and (probably) pipe and tile making from a shallow pit [588 219] near Bicester South railway station; the site is now occupied by the council highways depot and allotments.

4.1.2 Kellaways Sand Member

The Kellaways Sand Member forms subtle hills near Little Chesterton, and makes a slight scarp readily traceable north-eastwards from Bicester Sewage Works [580 212], which defines the southern bank of the Langford Brook. The outcrop is characterised by brown loamy soils, and pale brown to buff silty sand is commonly seen where dug from excavations or animal burrows. The fact that the member gives rise to a weak positive topographic feature may indicate partial cementation of these sands, but no sandstone has been noted either at outcrop or in borehole logs. In boreholes, the member is recorded as being composed of very fine-grained quartz sands, silts and silty mudstones. The thickness appears to be in the range 2 to 3 m, thickening occurring mainly at the expense of the underlying Kellaways Clay.

4.2 Oxford Clay Formation

Whilst normally associated with areas of low relief, the outcrop of the Oxford Clay in the south-east of the area is dominated by Graven Hill, the highest ground of the Bicester area (115 m OD). The formation has traditionally been divided into the Lower, Middle and Upper Oxford Clay, which are now formalised as Peterborough Member, Stewartby Member and Weymouth Member respectively (Cox, Hudson and Martill, 1992). The total thickness of the formation in the region is about 70 m, of which an estimated 60 m are represented in this area.

4.2.1 Peterborough Member

The Peterborough Member, about 26 m in thickness, forms the lower slopes of Graven Hill. It consists mainly of interbedded greenish grey, slightly blocky mudstones and brownish grey, fissile, bituminous, shelly mudstones and debris. Such material, dominated by the characteristically shaly mudstone, was observed amongst the debris from numerous excavations within the MOD depot. In the near-surface zone this weathers to a pale grey clay with ochreous mottles, but the soil is typically of a darker brown colour, and of a more crumbly texture, than younger parts of the formation. The top of the member has been mapped at a rather diffuse concave break of slope corresponding with a soil colour change, and occurs approximately at the 80 m contour on the hill.

Beds of grey septarian argillaceous limestone (cementstone) nodules occur at five principal levels within the Peterborough Member of this region (see Horton et al., 1995). Although none have been observed at outcrop within the Bicester area, their horizons can be inferred from the gamma-ray log of the Bicester Borehole, in which the base of the Peterborough Member occurs at 25.9 m below the borehole datum depth (which is c. 6 m above ground level). The levels of these markers (and the level above the base of the Peterborough Member) is given below:

Acutistriatum Band	9.4 m depth	16.5 m above base
Blackthorn Nodule Bed	12.2	13.7
Wendlebury Nodule Bed	18.0	7.9
Arncott Nodule Bed	21.9	4.0

Merton Nodule Bed	23.5	2.4
Base Peterborough Member	25.9	0.0

This interpretation is somewhat tentative except in the case of the Acutistriatum Band which forms a most marked and distinctive peak closely comparable with that in other boreholes outside the area. It should be noted that the classification above differs somewhat from that of Ambrose (1988; see fig. 34 of Horton et al., 1995).

4.2.2 Stewartby Member

The Stewartby Member, about 21 m thick consists predominantly of pale to medium grey, smooth to slightly silty, calcareous, poorly fossiliferous, blocky mudstones. It weathers to produce a dull mid greyish brown soil, much heavier and stickier than that characteristic of the Peterborough Member. It forms the steepest part of Graven hill; a positive, shelf-like feature marks the top of the member; this is formed by nodular limestones or calcareous siltstones. Particularly pale grey marly clay associated with chips of cream-coloured soft limestone, and fragments of *Gryphaea* found at this level [591 205] probably represent the Lamberti Limestone, the topmost bed of the member, and of the Callovian Stage (and Middle Jurassic).

4.2.3 Weymouth Member

The basal 15 m or so of the Weymouth Member (Oxfordian; Upper Jurassic) form the upper part of Graven Hill. It consists mainly of pale grey, smooth-textured mudstones and slightly silty mudstones, debris of which was found around the water tank [591 204].

5 STRUCTURE

The structure as seen in the Jurassic rocks of the district is simple. In the greater part of the area, the strata dip gently and fairly uniformly to the south-east, with a mean dip of about 7.5 m per km (0.4°), as demonstrated by the extensive Cornbrash dipslope which descends beneath younger cover in the south-east. The reappearance of the Cornbrash in the extreme south-eastern corner of the area, dipping north-west at perhaps 2°, demonstrates the presence of a shallow south-west to north-east trending syncline, judged to run very approximately beneath Graven Hill. In the axis of this fold the Cornbrash is estimated to reach a maximum depth of about 50 m OD, i.e. some 15 m lower than at outcrop.

The Forest Marble and White Limestone come to outcrop a few hundred metres farther south-east along the crest of the parallel Charlton Anticline. From geophysics (chiefly aeromagnetic data), it is deduced that the ?Silurian volcanic rocks encountered in the Bicester Borehole 'crop out' beneath the Mesozoic cover roughly along the line of this anticline. It is likely that basement faults bring the volcanic rocks to crop there, and that they form a topographic high on the basement surface. Together, these phenomena are probably responsible for the folding of the weaker cover rocks, which are 'draped' over the basement irregularities.

A considerable amount of faulting (with modest throws) is associated with the anticline, one of which extends onto Sheet SP 52 SE [597 200].

6 QUATERNARY

6.1 River Terrace Deposits

Deposits of sand and gravel in the south-west of the district are river terraces related to the Langford Brook, and its various tributaries. The Brook is itself a tributary of the River Ray which joins the Cherwell at Islip [523 137], and thence flows to the Thames at Oxford.

The oldest deposits, herein classified as belonging to the **Second Terrace**, equate with the 'Third Terrace deposits' of Ambrose (1988). They cap two low hills near Little Chesterton [554 200; 563 208], where they give rise to brown loamy soils in which a scatter of Jurassic limestone pebbles may be brought to the surface by ploughing. More generally, pebbles are absent in the soil, suggesting partial decalcification. Their leached and oxidised condition, the substantial lateral separation from the modern streamways, and higher elevation (by some 5 m or more), are evidence of some antiquity. As such, the deposits are likely to be cryoturbated into the underlying clays and sands of the Kellaways Formation and thus probably of very variable thickness. Nevertheless, it seems unlikely that thicknesses much greater than 1m would be encountered.

The Second Terrace Deposits may equate with part of the composite Summertown-Radley Member of the Thames succession (see Sumbler, 1995) which is no younger than Early Devensian.

Deposits assigned to the **First Terrace** occur near the confluence of the Gagle and Langford Brooks, around Promised Land Farm [573 207] where they underlie a rather poorly formed terrace which rises up to about 1.5 m above the adjoining alluvial floodplain. This higher and drier ground is the site of the Roman settlement of Alchester, now evident only from various very subtle mounds and hollows.

The soil on the terrace is typically a dark, humic, slightly sandy loam containing abundant small (commonly c. 8 to 16 mm grade) pebbles of Jurassic limestone. In places, particularly just to the south of the area, the boundary of the alluvium is very difficult to define, presumably because floods encroach onto these low terraces from time to time.
The deposits evidently extend beneath the alluvium and are contiguous with sub-alluvial gravels. Thicknesses of up to 3 m are probable.

The deposits probably equate with the composite Northmoor Terrace of the Thames (see Sumbler, 1995) of Devensian age.

6.2 Alluvium

All of the minor streams in the north-western part of the area have a narrow alluvial floodplain, typified by calcareous clays with a basal gravelly lag deposit. Broader floodplains several hundred metres across occur along the Langford Brook and other streams such as the Gagle Brook where they flow onto the Kellaways Formation and Oxford Clay. This material is composed of dark humic and locally rather peaty clays and silts, commonly highly calcareous. This material is of variable thickness and is generally underlain by a more or less sandy gravel of limestone pebbles, similar to that of the first terrace, and indeed probably largely belonging to that unit, albeit partially reworked by the modern streams. A few site investigation boreholes in the floodplain of the Langford Brook show that the deposits (loam and any underlying gravel) reach up to about 2.5 m thick.

The Alluvium is probably mainly of Flandrian age but as mentioned above, may include older gravels.

6.3 Artificial deposits and worked ground

An attempt has been made to map the principal areas of made and worked ground, but the map is not claimed to be comprehensive in this respect. For example, much of the ground within the industrial and housing estates of Bicester has been remodelled to some extent, but it is not now possible to discern the limits of such disturbance.

7 UNPUBLISHED INFORMATION SOURCES

The following lists the principal items of unpublished data that were consulted and considered in connection with the survey of Sheet SP 52 SE. All this data is held in BGS archives, and in most cases may be consulted on application to BGS. Other published data pertinent to the area is referred to in the text and listed in References

7.1 Boreholes

As of the date of this report, BGS held records of water wells, boreholes and trial pits for 160 sites within Sheet SP 52 SE. These records are held in the National Geological Records Centre at BGS Keyworth. Each is given a unique registration number, in which the borehole logs for each 1:10 000 sheet are numbered consecutively in order of acquisition; thus the full designation is in the form SP 52 SE/1. The majority of the records relate to trial pits less than 2 m deep, but the sites of deeper and more significant boreholes and wells are indicated on the map. The geological data vary greatly in terms of quality and reliability; those with useful and interpretable geological records are summarised in Appendix 1.

7.2 Maps

The following large-scale geological maps fall entirely or in part within Sheet SP 52 SE; these unpublished maps are held in the National Geological Records Centre at BGS Keyworth.

Oxfordshire 23 NW c. 1907. 1:10 560-scale MS 'railway notes' by G Barrow (see Barrow, 1908)

Overall this and other old small-scale maps (Old Series One-Inch (1:63 360-scale) Sheet 45 SE) provide minimal information and are entirely superseded by those of the most recent survey:

SP 52 SE M G Sumbler 1999 1:10 000-scale MS field map (full survey)
SP 52 SE M G Sumbler 1999 1:10 000-scale MS standard (full survey)

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APPENDIX 1 BOREHOLES

The following are summarised interpretations of borehole and well logs. In most cases the depths (given in metres) are derived from rudimentary driller's logs or, in the case of the Bicester Borehole, mainly from geophysical logs, and are necessarily approximate.

SP 52 SE/1 [5878 2081] Bicester No 1 Borehole (1976) Datum +85.6 (Drilling Floor)

	Depth ft	Thickness m	Depth m
Oxford Clay Formation	*85.00*	25.91	25.91
Kellaways Formation: Kellaways Sand Member	*95.00*	3.05	28.96
Kellaways Clay Member	*101.00*	1.83	30.78
Cornbrash Formation	*110.00*	2.74	33.53
Forest Marble Formation	*120.00*	3.05	36.58
White Limestone Formation: Bladon Member	*131.00*	3.35	39.93
Ardley Member	*147.00*	4.88	44.81
Shipton Member	*161.00*	4.27	49.07
Rutland Formation	*186.00*	7.62	56.69
Taynton Limestone Formation	*209.00*	7.01	63.70
Sharp's Hill Formation	*220.00*	3.35	67.06
Horsehay Sand Formation	*230.00*	3.05	70.10
Northampton Sand Formation	*238.00*	2.44	72.54
Whitby Mudstone Formation	*267.00*	8.84	81.38
Marlstone Rock Formation	*272.00*	1.52	82.91
Dyrham Formation	*301.00*	8.84	91.74
Charmouth Mudstone Formation	*530.00*	69.80	161.54
Penarth Group	*533.00*	0.91	162.46
Mercia Mudstone Group	*553.00*	6.10	168.55
Old Red Sandstone	*1119.00*	172.52	341.07
Silurian sandstones	*1265.00*	44.50	385.57
Volcanic rocks of uncertain age	*1686.00*	128.32	513.89

SP 52 SE/2 [5572 2160] Chesterton Well (1949) Datum c +79 (Ground level)

	Depth ft	Thickness m	Depth m
Cornbrash Formation	*13.00*	3.96	3.96
Forest Marble Formation	*23.00*	3.05	7.01
White Limestone Formation: Bladon Member	*28.00*	1.52	8.53
Ardley Member	*62.50*	10.52	19.05
Shipton Member	*84.00*	6.55	25.60
Rutland Formation	*101.00*	5.18	30.78
Taynton Limestone [? and Charlbury] Formation	*118.00*	5.18	35.97
Sharp's Hill Formation and Horsehay Sand Formation	*130.00*	3.66	39.62

SP 52 SE/3 [5670 2207] Whitelands Farm Well (?1953) Datum c +76 (Ground level)

	Depth ft	Thickness m	Depth m
Cornbrash Formation	*9.00*	2.74	2.74
Great Oolite Group and Inferior Oolite Group undifferentiated	*138.00*	42.06	39.32

SP 52 SE/5 [5709 2384] Bicester Town Well (?1904) Datum +84.4 (Ground level)

	Depth ft	Thickness m	Depth m
Cornbrash Formation	*4.50*	1.37	1.37
Forest Marble Formation	*18.00*	4.11	5.49
White Limestone Formation: Bladon Member	*23.50*	1.68	7.16
Ardley Member	*54.00*	9.30	16.46
Shipton Member	*65.50*	6.86	19.96
Rutland Formation	*99.50*	10.36	30.33
Taynton Limestone Formation	*108.00*	2.59	32.92
Sharp's Hill Formation	*112.33*	1.32	34.24

SP 52 SE/6 [5851 2319] Bicester Station Well (? c. 1908) Datum +77.7 (Ground level)

	Depth ft	Thickness m	Depth m
Cornbrash Formation	*8.50*	2.59	2.59
Forest Marble Formation and White Limestone Formation: Bladon Member	*29.75*	6.48	9.07
Ardley Member and Shipton Member	*76.00*	14.10	23.16
Rutland and Taynton Limestone formations	*100.00*	7.32	30.48
Sharp's Hill, Horsehay Sand and Northampton Sand formations	*120.00*	6.10	36.58

SP 52 SE/7 [5854 2361] Laundry Well (1939) Datum c +79 (Ground level)

	Depth ft	Thickness m	Depth m
Cornbrash Formation	*8.00*	2.44	2.44
Forest Marble Formation	*18.00*	3.05	5.49
White Limestone Formation: Bladon and Ardley members	*40.00*	6.71	12.19
Shipton Member	*59.00*	5.79	17.98
Rutland Formation	*81.00*	6.71	24.69
Taynton Limestone Formation	*97.00*	4.88	29.57
Sharp's Hill and Horsehay Sand formations	*117.00*	6.10	35.66
Northampton Sand Formation	*118.00*	0.30	35.97
Whitby Mudstone Formation	*121.00*	0.91	36.88

SP 52 SE/8 [5852 2359] Laundry Well (1951) Datum +77.7 (Ground level)

	Depth ft	Thickness m	Depth m
Cornbrash Formation	*8.00*	2.44	2.44
Forest Marble Formation	*20.00*	3.66	6.10

White Limestone Formation	*60.00*	12.19	18.29
Rutland, Taynton Limestone, Sharp's Hill and Horsehay Sand formations	*120.00*	18.29	36.58

SP 52 SE/9 [5746 2424] Lord's Farm (1941) Datum c. + 81 (Ground level)

	Depth ft	Thickness m	Depth m
Forest Marble Formation	*6.50*	1.98	1.98
White Limestone Formation	*49.50*	13.11	15.09
Rutland Formation	*84.00*	10.52	25.60
Taynton Limestone, Sharp's Hill, Horsehay Sand and Northampton Sand formations	*119.50*	10.82	36.42
Whitby Mudstone Formation	*172.00*	16.00	52.43
Marlstone Rock Formation	*176.00*	1.22	53.64
Dyrham and Charmouth Mudstone formations	*262.00*	26.21	79.86

SP 52 SE/10 [c. 5919 2048] Graven Hill Well (1941) Datum +88 (Ground level)

	Depth ft	Thickness m	Depth m
Oxford Clay Formation	*128.00*	39.01	39.01
Kellaways Formation	*146.00*	5.49	44.50
Great Oolite and Inferior Oolite groups, undifferentiated	*281.00*	72.24	85.65
Whitby Mudstone Formation	*290.00*	2.74	88.39

SP 52 SE/11 [5865 2200] Joinery Works Well (1963) Datum c. +68 (Ground level)

	Depth ft	Thickness m	Depth m
Made Ground (? and Kellaways Clay Member)	*3.00*	0.91	0.91
Cornbrash Formation	*9.00*	1.83	2.74
Forest Marble Formation	*24.00*	4.57	7.32
White Limestone Formation	*76.00*	15.85	23.16
Rutland Formation	*87.00*	3.35	26.52
Taynton Limestone Formation	*100.00*	3.96	30.48
Sharp's Hill and Horsehay Sand formations	*119.00*	5.79	36.27
?Northampton Sand Formation	*121.00*	0.61	36.88

SP 52 SE/14 [5910 2446] RAF Bicester Well (1939) Datum c. +81 (Ground level)

	Depth ft	Thickness m	Depth m
Cornbrash Formation	*8.50*	2.59	2.59
Forest Marble Formation	*21.00*	3.81	6.40
White Limestone Formation: Bladon Member	*27.00*	1.83	8.23
Ardley Member	*61.00*	10.36	18.59
Shipton Member	*64.00*	0.91	19.51
Rutland Formation	*94.00*	9.14	28.65
Taynton Limestone Formation	*101.00*	2.13	30.78
Sharp's Hill, Horsehay Sand and Northampton Sand			

formations	*124.50*	7.16	37.95
Whitby Mudstone Formation	*140.00*	4.72	42.67

SP 52 SE/15 [5530 2007] M40 059 Borehole (1979) Datum c. +70.0 (Ground level)

	Thickness m	Depth m
Kellaways Formation: Kellaways Clay Member	3.90	3.90
Cornbrash Formation	3.05	6.95
Forest Marble Formation	4.65	11.60
White Limestone Formation: Bladon Member	1.60	13.20
White Limestone Formation: Ardley Member	4.30	17.50

SP 52 SE/25 [5505 2082] M40 059A Borehole (1979) Datum c. +70.0 (Ground level)

	Thickness m	Depth m
Cornbrash Formation	1.80	1.80
Forest Marble Formation	5.4	7.20
White Limestone Formation: Bladon Member	1.00	8.20
White Limestone Formation: Ardley Member	8.65	16.85
White Limestone Formation: Shipton Member	2.55	19.40

SP 52 SE/28 [5745 2086] Faccenda Chicken Ltd, Promised Land Farm Well (1983)
Datum c. +65 (Ground level)

	Depth ft	Thickness m	Depth m
Alluvium	*4.50*	1.37	1.37
Kellaways Formation: Kellaways Clay Member	*18.00*	4.11	5.49
Great Oolite Group	*50.00*	9.75	15.24

SP 52 SE/29 [5715 2388] Bicester Town No 2 Well (1936) Datum +85.3 (Ground level)

	Depth ft	Thickness m	Depth m
Forest Marble Formation	*17.00*	5.18	5.18
White Limestone Formation: Bladon Member and			
Ardley Member	*49.50*	9.91	15.09
Shipton Member	*66.50*	5.18	20.27
Rutland Formation	*90.00*	7.16	27.43
Taynton Limestone Formation	*102.00*	3.66	31.09
Sharp's Hill and Horsehay Sand formations	*124.00*	6.71	37.80
Northampton Sand Formation	*127.00*	0.91	38.71
Whitby Mudstone Formation	*142.50*	4.72	43.43

SP 52 SE/50 [5501 2074] M40 234G Borehole (1987) Datum c. +73.2 (Ground level)

	Thickness m	Depth m
Cornbrash Formation	2.65	2.65
Forest Marble Formation	4.70	7.35
White Limestone Formation: Bladon Member	3.10	10.45
White Limestone Formation: Ardley Member	9.25	19.70

White Limestone Formation: Shipton Member	0.50	20.20

SP 52 SE/78 [5827 2138] Bicester Sewage Works Borehole 421/4 (1986) Datum c. +68.4 (Ground level)

	Thickness m	Depth m
[? Made Ground and] Kellaways Formation: Kellaways Sand Member	7.80	7.80
Kellaways Formation: Kellaways Clay Member	2.80	10.60
Cornbrash Formation	1.00	11.60

SP 52 SE/95 [5846 2160] Bicester ByPass No 9 Borehole (1984) Datum c. +65.6 (Ground level)

	Thickness m	Depth m
Alluvium	2.50	2.50
Kellaways Formation: Kellaways Clay Member	1.65	4.15
Cornbrash Formation	3.15	7.30
Forest Marble Formation	4.00	11.20
White Limestone Formation: Bladon Member	2.90	14.10
White Limestone Formation: Ardley Member	9.25	23.35
White Limestone Formation: Shipton Member	1.65	25.00

SP 52 SE/159 [5757 2032] Alchester House Well (1995) Datum c. +64.0 (Ground level)

	Thickness m	Depth m
Alluvium and/or River Terrace Deposits	2.10	2.10
Oxford Clay Formation	5.40	7.50
Kellaways Formation: Kellaways Sand Member	2.50	10.00
Kellaways Formation: Kellaways Clay Member	2.50	12.50
Cornbrash, Forest Marble and White Limestone formations	12.50	25.00