NATIONAL DEVELOPMENT PLAN

National Roads Authority
An tÚdarás um Bóithre Náisiúnta

M7 HEATH – MAYFIELD MOTORWAY SCHEME

M7 Heath – Mayfield Archaeological Investigation Contract 4

Site: Cappakeel 3, County Laois

NGR:	255285, 204876
Chainage:	N1200
Excavation No:	03E1724

Excavation Report

Director: Jonathan Dempsey

September 2005

Meanma agus Misneach

Kildare County Council

ARCHAEOLOGICAL CONSULTANCY SERVICES

PROJECT DETAILS

Project	M7 Heath-Mayfield Motorway Scheme
Archaeologist	Jonathan Dempsey
Client	Kildare County Council, National Roads Design Office
Site	Cappakeel 3
Townland/Town	Cappakeel
Parish	Coolbanagher
County	Laois
Nat. Grid Ref.	255285, 204876
Chainage	N1200
Licence No.	03E1724
Project Start Date	October 2003
Report Date	September 2005

NON-TECHNICAL SUMMARY

Resolution excavation in advance of construction of the M7 Heath-Mayfield Motorway Scheme was carried out at Cappakeel 3, Cappakeel Townland, County Laois (centred on Nat. Grid Ref. 255285, 204876) under Licence Number 03E1724, issued to Jonathan Dempsey by the Department of the Environment, Heritage and Local Government. The excavated features consisted of a sunken charcoal pile, two pits, and an irregular pit with a slag-rich fill. Charcoal from the fill of the sunken charcoal pile could not be identified. It was not possible to date this feature. The presence of a sunken charcoal pile and the remains of a pit with residues of iron smelting would indicate that these features were associated with this process.

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1. INTRODUCTION

Resolution excavations were undertaken at Cappakeel 3, Cappakeel Townland, County Laois, of features identified by archaeological monitoring of topsoil stripping in advance of the M7 Heath-Mayfield Motorway Scheme. The excavation was carried out on behalf of Kildare County Council, National Roads Design Office, under Licence Number 03E1724, issued to Jonathan Dempsey by the Department of the Environment, Heritage and Local Government. The work was undertaken between 14th and 17th October 2003.

2. THE DEVELOPMENT

2.1 The Site

Cappakeel is located within the roadline in the townland of Cappakeel 3km southwest of Ballybrittas and 750m northeast of the New Inn Cross Roads (see Figures 1 and 2). Cappakeel 2 (Licence Number 03E1048) is located 450m to the south-southeast. This site consisted of a charcoal burning platform and a possible hearth base. The Record of Monuments and Places (R.M.P.) for County Laois lists one Recorded Monument in Cappakeel Townland. This is an earthwork enclosure (LA 009:0202) shown on the Ordnance Survey 6" 1st edition of 1839, County Laois Sheet 9, with a diameter of 20m. No visible surface traces of this monument were recorded by Sweetman *et al* (1995, 63).

2.2 Proposal

The M7 Heath-Mayfield Motorway Scheme involves the construction of approximately 17.5km of motorway and passes through two counties, Kildare and Laois. Beginning in Mayfield townland at the western end of the Kildare Town By-pass, the scheme moves westward to the south of the existing N7 before finally re-joining the existing road at the eastern end of the Portlaoise By-pass in Greatheath townland.

As part of the Environmental Impact Assessment and subsequent works, a number of archaeological impact assessments were undertaken by Valerie J. Keeley Limited. These included desk-based studies, an aerial survey and field inspections. Pre-construction archaeological investigations were undertaken by the same consultancy as part of Contracts 1, 2 and 3. These contracts included architectural recording, intrusive testing of potential archaeological sites, centreline testing with offsets (Licence Numbers 03E026, 03E1027, 03E1028) and the resolution of sites of archaeological significance identified by these assessments and the testing.

Contract 4 was archaeological monitoring of the construction topsoil strip and was undertaken by Archaeological Consultancy Services Ltd. under Licence Number 03E0623, granted to Jonathan Dempsey by the Department of the Environment, Heritage and Local Government on 25th April 2003.

3. ARCHAEOLOGICAL EXCAVATION

3.1 Archaeological and Historical Background

Created a county in 1556 and formerly called Queen's County, the landscape of Laois is dominated by tillage and pasture. The underlying rock of the lowlands is limestone and the county rises in the north to the Slieve Bloom Mountains where the underlying geology is sandstone. The largest rivers in the county are the Nore and the Barrow.

Activity from the Neolithic period (4000–2400BC) is poorly represented in County Laois. No definite megalithic tombs (court tombs, portal tombs, passage tombs and wedge tombs) have been identified in the county, although Sweetman *et al* (1995) recorded eight possible examples. Hilltop cairns which have their origins in the Neolithic period have also been recorded. Such monuments would have performed a number of functions including depositories for the dead, settings for religious activity and markers in time and space.

Towards the end of the third millennium BC, significant changes occurred in pottery and, with the introduction of bronze, technology. Changes also occurred in burial rites. While in the Neolithic period the remains of a number of individuals were placed in the chambers of megalithic tombs, in the Early Bronze Age the dominant rite was for individual inhumations or cremations in cists or pits. Such cists and pits occur singularly or in groups. They can have no apparent surface indications or can occur under burial mounds or be inserted into earlier mounds. Where composed primarily of stone, these mounds are known as cairns and where made mainly of earth they are known as barrows. Monument types within the barrow class include the ring-barrow where the mound is enclosed by an outer ditch and bank and bowl barrows which have a central dome-shaped mound. It is probable that some of the sites identified as ring ditches from aerial photographs are ploughed-out ring-barrows. Evidence indicates that the tradition of placing inhumations or cremations under or into mounds continued into the Iron Age (see below).

Stone circles, standing stones and stone alignments also date to the Bronze Age period. The Record of Monuments and Places (RMP) records seven stone circles in County Laois, while forty-eight standing stones have also been recorded. The most widespread Bronze Age sites are *fulachta fiadh* or burnt mounds. The RMP records twenty such monuments in County Laois, although a number of *fulachta fiadh* have been identified by recent archaeological work in advance of road construction. Three *fulachta fiadh* were excavated ahead of the Portlaoise By-pass in Derry townland [(1)], and three on the Carlow Northern Relief Road [(2)]. Extant sites of this type often consist of a mound of burnt stone, soil and charcoal generally associated with a water-filled trough. Where the mound has been ploughed out, such sites are often identified as spreads of burnt material. Excavation has revealed that troughs, pits and stakeholes are often associated with such sites. It is thought that hot stones were added to the water in the trough to heat it, although for what purpose remains open to interpretation. The most popular suggestions are that these were used for cooking or as sweat lodges.

One crannóg is recorded in the county (LA028:090). While also dating to later periods, such sites may have had their origins in the Bronze Age. Settlement sites of the Iron Age (*c.*700BC–AD400) are extremely difficult to identify in the landscape. Three hillforts and one possible hillfort have been identified in the county (Sweetman *et al* 1995). Such sites may have their origins in the Late Bronze Age. One inland promontory (or cliff-edge fort) has been identified in Ballyprior townland (ibid). Based on comparisons with coastal promontory forts, inland promontory forts are traditionally ascribed an Iron Age date. In comparison with the settlement record and with evidence from the rest of the country, the funerary record is relatively rich. An Early Iron Age archaeological complex was excavated at Ballydavis in the course of the construction of the Portlasois By-Pass. Excavated features included four ring-ditches, furnaces and pits and the finds comprised a bronze box, fibulae, glass beads and bronze and iron objects (Keeley 1999, 25). The central cremation in Site 1, a 16m diameter ring-ditch, produced a rich artefactual assemblage including a fibula, over eighty stone and glass beads and a cylindrical bronze box which has parallels with a similar container from a chariot burial at Wetwang Slack (Waddell 1998, 368). Further ring-ditches were excavated in Ballydavis townland in advance of construction of the present M7 Heath-Mayfield Motorway Scheme. Nine ring-barrows have been previously recorded in the area surrounding Ballydavis (Sweetman *et al* 1995). While a long chronology for the construction and use of ring-barrows is noted, these monuments may be contemporary with the Ballydavis complex excavated by Keeley.

The county of Laois takes its name from the Laigis who were regarded as descendants of the *Cruthin* or *Cruithne* (O'Murchadha 1999). An historical tract known as *De Peritia et Genealogia Loichsi* provides information the history of the Laigis. The territory of the Laigis was divided into a number of territorial divisions known as septs including the sept of *Mag Rechet* which corresponds to Morrett townland including the Great Heath. The present scheme passes through these townlands. Possibly providing continuity with earlier periods, the Great Heath was the ritual focus of this sept. After the decline of Anglo-Norman control of the area and the re-emergence of O'More influence, Feehan suggests that the Great Heath was removed from cultivation (1999, 11).

The pre-eminent sept was *Mag Reta* including the early medieval dun [(3)] at Dunamase (*Dun Masc*). The kings of *Mag Reta* were the kings of the Laigse, and it was from these that the O'Mores were descended. The fortunes of the Laigis declined in the tenth century and the territory under their control also declined. Some influence was regained immediately prior to the Anglo-Norman colonization (*ibid*, 54).

The archaeology of the early medieval period (AD400–800) in this area is characterised by ringforts, souterrains and ecclesiastical sites. The term 'rath' is used where a ringfort is defined by an earthen bank. Univallate enclosures, where the site is defined by a single bank, are the most common type of ringfort. The entrance into a ringfort usually comprises an un-dug causeway across the ditch leading to a gap in the bank(s). It is probable that each ringfort was a farmstead occupied by a single family unit and their retainers (Stout 1997, 32). While such sites had a protective function, such as the defence of stock from cattle raiding, the size and type of enclosure may also have reflected the status of the inhabitants. The

RMP for County Laois records 172 ringforts and raths. A ringfort has been recorded in Ballybrittas townland (LA009:009). A total of 348 enclosures are also recorded, including examples in the townlands of Cappakeel (LA009:020) and Rathnalulagh (LA014:001). The majority of these enclosures are possibly of early medieval date. While undated, it is possible that the field systems recorded in the townlands of Ballyprior and Ballycoolan, south of Stradbally, date to the early medieval period given their proximity to a number of ringforts (Feehan 1999, 17). In Morett townland a horizontal mill (LA009:022) of early medieval date was excavated in the 1950s (Lucas 1953).

Souterrains are underground or semi-subterranean passages and have been found in association with ecclesiastical sites, enclosed and unenclosed settlements and isolated examples may indicate the former presence of an unenclosed settlement. A total of eleven souterrains are recorded in the RMP for the county. A variety of techniques were used in the construction of souterrains. Earth-cut, rock-cut, a combination of earth-cut and rock-cut or, less commonly, tunnelled souterrains all exist. The supporting walls are commonly of drystone construction and are roofed with stone, although wooden variants have also been excavated. Internal features of souterrains include creeps and blinds, drains and murder holes. These features suggest that souterrains were used for refuge, although they may also have been used for storage. The majority of souterrains date to the Early Christian period, in particular to the eighth to the twelfth centuries AD (Clinton 2000a).

The introduction of Christianity in the fifth century led to the development of numerous monastic foundations throughout Laois. By the eighth century, the layout of these ecclesiastical centres had formalised into two concentric enclosures: an inner enclosure surrounding a church and graveyard and an outer enclosure surrounding dwellings and workshops. In addition to their religious functions, monasteries became centres for trade and crafts, performing many proto-urban (central place) functions. Patronage from wealthy aristocrats ensured not only that many monasteries were wealthy and powerful, but also that religious and secular power was connected and that the fortunes of the monasteries were linked to the fortunes of the patrons.

Johnston suggests that while Kildare was the most powerful church in Leinster, the monastery at Clonenagh founded by St Fintan in *c.*AD548 had the most influence in Laois. The monastery at Terryglass through its links with Clonenagh also had considerable influence despite being in Munster. Other influential monasteries in the county included Aghaboe, Clonfertmulloe, Sletty and Timahoe (Johnston 1999).

The second reform synod of AD1111 held at Rathbreasail and the later Anglo-Norman colonization of the county removed the power and influence of the old monastic churches. One of the main beneficiaries of this decline was the Cistercian order and lands were granted to them by Dermot O'Dempsey to found an abbey at Monasterevin in 1189, possibly on an existing ecclesiastical site. Monasterevin was located at a fording point on the River Barrow for the *Slighe Dala* (Carville 1999).

A wide variety of sites are termed holy wells. A total of forty-five holy wells have been recorded in County Laois (Sweetman *et al* 1995) including St Bridget's Well at Morett (LA009:021/03). It is possible that some holy wells may be pre-Christian sites, later converted to Christianity while others are the sites of earlier ecclesiastical activity while. It is also likely that other examples are of recent origin.

The Anglo-Norman conquest of Laois began in 1169 when MacGillapatrick invaded Laois with Maurice de Predergast (Ó'Cléirigh 1999, 164). It was the Anglo-Normans who constructed ringworks, motte-and-baileys, stone castles and later, moated sites. Mottes comprise flat-topped steep-sided conical mounds surrounded by a bank and ditch. Timber buildings and defences would have been located on the flat summit of the motte. The bailey is an outer enclosure which may or may not be attached to the motte. The buildings and defences of baileys would also have been constructed of wood. Eighteen motte-and-baileys have been recorded in County Laois. Stone castles were also constructed. The Rock of Dunamase became the most important Anglo-Norman fortification in Laois. Built by Meiler Fitzhenry on the site of an early medieval fortification, the first castle comprised a keep enclosed by a curtain wall. A lower ward and inner and outer barbican were added by William Marshall after 1208 (Bradley 1999).

The Anglo-Normans founded a number of manors, boroughs and towns. There is historical evidence for the foundation of at least three boroughs in the east of the county: Castletown, Kilabban and Newtown of Leys. Evidence suggests earlier secular or religious centres at Kilabban and Newtown of Leys close to the Rock of Dunamase. Anglo-Norman colonization in Laois was not as successful as neighbouring Kildare and throughout the fourteenth century the boroughs declined.

Tower houses, or fortified stone residences, were built in County Laois from the fourteenth to the seventeenth centuries. Sweetman *et al* describe tower houses as being "rectangular in plan, up to five storeys high, often with two diagonally opposed projecting angle towers and usually containing such features as a barrel vault over the ground floor, mural passages, stairwell, garderobe and murder-hole (Sweetman *et al* 1995, 110). The RMP records thirty-four tower houses in Laois including an example in Morett (LA009:021/01) which was built in the late sixteenth century by the Fitzgeralds on an earlier site. A chapel of ease was also constructed in Morett close to the castle (LA009:021/04) along with a road linking the castle at Morett to Coolbanagher Castle (LA008:015).

The failure of Thomas Fitzgerald's revolt (1534–36) led to the suppression of the Fitzgeralds and their allies in Laois. The counties of Laois and Offaly were confiscated by the Crown in 1557. To control the area, attempts were made to plant the counties of Laois and Offaly with English, Welsh and Scottish settlers but these were not successful until the late sixteenth century. New towns were established including Fort Protector (later Maryborough and later still Portlaoise) in 1548 and Ballinakill in 1570. The newly-created barony of Portnahinch was made up of the territory of Clanmalire and Irry was also partially planted. Clanmalire extended from the Barrow in the east to Morett and Lea Castles in the west with north and south borders formed by the Barrow and Morrett Rivers. Irry was located immediately to the west and both areas appear to be bog or woods (Cosby 1999, 308). Clanmalire was the preserve of the earls of Kildare and the O'Dempseys. Before it was escheated in 1570, the earl of Kildare held Cappakeel between Morett and Ballydavis (LA009:010). Morett also belonged to the earl of Kildare and was leased to his son Gerald in 1585. Gerald was murdered in the 1590s and the castle was burnt at the same time. The O'Dempsey's land amounted to 3,300 acres and was centred on the castle at Ballybrittas. Part of this was granted to Robert Harpole in 1564.

The seventeenth century was a time of unrest in the county with skirmishes and sieges related to the Catholic rebellion, the reaction of the government forces under Ormond, the campaigns of the Confederate Army and Cromwell and later the Williamite Wars. In contrast, the eighteenth century was a time of stability and this is reflected by the construction of grand country houses and the development of estates and estate villages. Mountrath, Portarlington and Rathdownwy, although founded in the seventeenth century, developed in the eighteenth along with Mountmellick, and estate villages such as Abbeyleix, Durrow and Stradbally were built. Jamestown House (NIAH 12800917) in Jamestown townland was built around 1740.

Communications were also improved in the eighteenth century with the construction of a number of bridges and roads, the latter indicated by the survival of milestones. By 1790, the Grand Canal had been linked to Mountmellick and the Barrow Navigation System.

While towns continued to grow in the nineteenth century and industry developed, the economic basis of the county remained essentially agricultural and this resulted in the landscape of small enclosed fields, dispersed farmsteads and small villages which are all visible on the Ordnance Survey first-edition six-inch map of the 1830s. A distinctive feature of the vernacular agriculture of County Laois of this period is thatched mud-walled buildings. It was also during the nineteenth century that a number of estates were remodelled and that country houses such as Bellegrovehouse (NIAH 12800907) in Bellegrove townland southeast of Ballybrittas were built.

3.2 Methodology

Features uncovered in the course of archaeological monitoring of the main construction topsoil strip (Archaeological Investigations Contract 4) were fenced off using road irons and hazard tape, and the Project Archaeologist and the Project Engineer were informed. The immediate areas around the identified features were cleaned by hand. All features were fully excavated by hand and a full written, drawn and photographic record was produced. Each feature was related to Ordnance Datum and the National Grid.

3.3 Results of Excavation

The archaeological features identified at Cappakeel 3 consisted of a sunken charcoal pile (**C301**), two pits (**C302** and **C303**) and possible pit (**C304**).

Sunken Charcoal Pile

Located at a height of 82.2mOD, **C301** was a suboval pit with rounded corners which measured 1.6m northwest to southeast by 1.1m northeast to southwest by 0.26m deep (see Figures 4 and 8; Plates 1, 2 and 3). The break of slope at the top of the pit was sharp, the sides sloped gradually and were straight, apart from the eastern side which was slightly concave. The break of slope at the base of the slope was imperceptible and the base (at 81.074mOD) was flat. The base and sides of this pit were moderately oxidized (**C305**). This layer was 60mm thick.

A total of two fills were identified in C301. **C306** consisted of a dark brownish-black silty clay with frequent flecks and larger fragments of charcoal and occasional rounded stones. C306 was 0.12m thick. This was overlain by **C307**, a loose dark-brown silty clay, 0.13m thick, with occasional charcoal flecks.

C301 was interpreted as the remains of a sunken charcoal pile.

Pits

C302 was a suboval pit with rounded corners (see Figures 5 and 8; Plate 4). This feature was located 227m north-northwest of C301 at a height of 82.76mOD. C302 measured 1.38m north to south by 0.99m east to west by 0.5m deep. The base of this pit measured 0.28m north to south by 0.3m east to west. The break of slope of the top of this feature was sharp, the sides were irregular, and the break of slope at the base was sharp. The western side of the pit had a sharper slope than the eastern side. The base was flat.

The primary fill of C302 was **C308**. This was a friable, dark brown sandy silt with occasional subrounded stones up to 10mm in length. This context was 0.13m deep at its greatest depth and was well sorted, with a sharp upper boundary with the overlying fill (**C310**) and a lower boundary with the cut of the pit (C302). C308 was probably a slippage layer. Lenses of greyish white ash (**C309**) were visible towards the upper extent of C308.

The overlying context, C310, consisted of soft orangey brown sandy silt with occasional flecks of charcoal, subrounded to subangular stones up to 20mm in length, and occasional lenses of ash and oxidized clay. This context was 0.23m thick at its greatest extent. C310 was well sorted and had a diffuse upper boundary with the overlying fills (**C311** and **C312**).

C311 was a friable orangey-brown sandy silt with occasional flecks of charcoal, occasional subrounded to subrectangular stones up to 30mm in length and occasional lenses of grey white ash. This fill was heavily oxidized. It was also well sorted and had a diffuse boundary with C310.

C310 was also overlain by C312. This was a soft black-brown sandy silt with moderate flecks of charcoal, occasional subrounded to subangular stones up to 15mm in length and occasional lenses of ash. This well-sorted context was 0.17 m thick.

C303 was located 129m north-northwest of C302 at a height of 81.6mOD (see Figures 6 and 8; Plate 5). This feature was suboval in shape. It was orientated from north-northeast to south-southwest and was 1.35m long. The feature was 0.52m in width at the south-southwest and narrowed to 0.29m in width at the north-northeast. C303 was 0.29m deep at its greatest depth. The break of slope at the top of the feature was sharp. The northern and southern sides were vertical; the western side sloped gently and was concave in shape; the eastern side was slightly concave. There was a moderate break of slope at the base of this feature. The base (at 81.198mOD) of this feature was flat.

The north-northeastern side of C303 had been partially cut by a posthole (**C326**). The posthole was suboval in shape and measured 0.17m north-northwest to south- southeast by 0.12m east to west by 90mm deep. C326 was filled by **C327** a charcoal-rich silty sand. The presence of charcoal in C327 indicates that the post in C326 was burnt *in situ*, although no definite post pipe was identified.

The basal fill of C303 was **C316**. This was a medium compact, fine-grained whitish-brown silty sand with occasional charcoal inclusions, and small subrounded stones. C316 had a maximum thickness of 0.1m. This context is best interpreted as a layer of natural backfill. C316 was overlain by **C314**, a loose, fine-grained, dark-brown silty sand with frequent flecks of charcoal and occasional lenses of red oxidized clay. The charcoal flecks increased in frequency towards the north-northeast, and may have resulted from the burning of the post contained by posthole C326. C314 was 0.11m thick and was overlain by **C315**. C315 was a fine-grained, friable light brownish-grey sandy silt with occasional charcoal flecks and small subangular stones. This context was 0.19m thick.

Pit ?

Located 18.6m to the north-northwest of C303 at a height of 81.194mOD, **C304** was a large irregular feature which measured 2.2m north-northeast to south-southwest by 1.7m east to west (see Figures 7 and 8; Plate 6). C304 lay partially under the western verge of the road. This feature was excavated to a depth of 0.59m (80.60mOD). The sides and base of this feature were very irregular. The basal fill of C304 was a loose dark-grey sandy silt with moderate inclusions of slag and charcoal (**C324**). C324 was on average 0.15m thick and was overlain by **C325**, a loose mid-grey silty sand with moderate slag and charcoal inclusions. C325 was in turn overlain by a layer of charcoal 85mm thick (**C323**). Moderate inclusions of slag and frequent lenses of silty sand were present in this context. **C322** overlay C323. C322 consisted of a loose mid-grey silty sand with moderate inclusions of charcoal flecks and slag. C322 was 0.25m thick and was overlain by **C319**, a layer of silty sand with moderate lenses of grey white ash, slag and charcoal. C319 was 60mm thick. Overlying C319 was **C318**. This was a layer of charcoal 0.16m thick with moderate inclusions of silty sand and slag. C318 was in turn overlain by **C317** a loose mid-grey silty sand with frequent charcoal flecks and occasional fragments of slag. This context was 80mm thick.

Five hundred and seven pieces of industrial residues were recovered from C304. The slag weighed a total of 7.6kg and all pieces were examined in detail (Fairburn 2004; see Appendix 3). The industrial residues consisted of material associated with iron working: tap slag, furnace slag, iron ore, amorphous slag and clay lining and it is suggested that they are residues of iron smelting (*ibid*).

3.4 List of Contexts

Context Number	***Context Description***
C301	Cut of charcoal kiln
C302	Cut of pit
C303	Cut of pit
C304	Pit ?
C305	Basal fill of C301
C306	Fill of C301
C307	Fill of C301
C308	Primary fill of C302
C309	Fill of C302
C310	Fill of C302
C311	Fill of C302
C312	Fill of C302
C313	Fill of C302
C314	Primary fill of C303
C315	Fill of C303
C316	Fill of C303
C317	Fill of C304
C318	Fill of C304
C319	Fill of C304
C320	Fill of C304
C321	Fill of C304
C322	Fill of C304
C323	Fill of C304
C324	Fill of C304
C325	Fill of C304
C326	Cut of posthole in eastern side of C303
C327	Fill of C326

3.5 List of Samples

Sample Number	**Context Number**	**Description**
S1	C314	Charcoal for flotation
S2	C305	Soil for flotation
S3	C306	Soil for flotation

S4	C310	Soil for flotation
S5	C310	Soil for flotation
S6	C311	Soil for flotation
S7	C312	Soil for flotation
S8	C314	Soil for flotation
S9	C313	Soil for flotation
S10	C318	Soil for flotation
S11	C319	Soil for flotation
S12	C323	Soil for flotation
S13	C325	Soil for flotation
S14	C318	Slag from C318
S15	C319	Slag from C319
S16	C323	Slag from C323
S17	C322	Slag from C322
S18	C324	Slag from C324
S19	C325	Slag from C325
S20	C315	Soil from C315
S21	C306	Soil from C306
S22	C307	Soil from C307

The following soil samples have been processed and the results are shown below:

Sample Number	**Context Number**	**Weight of sample pre-flotation:**	**Material Recovered:**
S2	C305	2.5kg	Small amount of charcoal & snail shells.
S9	C313	0.5kg	72g charcoal

Charcoal recovered from C305 (S2) was sent for species identification (Akenet 2004: see Appendix 2). The sample consisted of charcoal fragments that were too small to be identified. The only plant remain apart from charcoal was a single achene of buttercup (*Ranunculus subgenus Ranunculus*) (*ibid*). As it was not possible to get a positive species identification of the charcoal in this sample, it was not submitted for radiocarbon dating.

4. DISCUSSION

Although more suboval in shape that other subrectangular excavated examples, the evidence for *in situ* burning and the charcoal-rich fill of C301 suggest that this feature was the remains of a sunken charcoal pile.

C005 was a small, heavily truncated pit with a heavily oxidized fill. The small size of this pit, the lack of evidence for *in situ* burning, and the lack of slag present, indicate that this pit is not a smithing or smelting hearth base, but rather a pit into which burnt material was dumped.

The shape of the pit, the evidence for *in situ* burning, and the charcoal-rich fill of C001 all suggest that this feature was the remains of a sunken charcoal pile (Pleiner 2000, 122). Rather than charcoal kilns, or deeper, narrower, charcoal production pits, these features were the sunken bases of piles or heaps of wood that were built up above ground and coated with an insulated layer of clay or earth (*ibid*). In addition to a charcoal rich fill excavation has uncovered evidence for the oxidization on the base and sides of these features (*ibid*).

Charcoal was produced by controlled burning of wood in a reducing atmosphere into which the amount of air present is carefully controlled, so that the wood is roasted but not actually burnt. The time taken to produce charcoal depends on the amount of wood used, the weather conditions and the moisture content of the wood. A temperature of between 600° and 900° centigrade is required and, while the amounts of charcoal produced vary, the residue will be about 10% of the raw material. This produces a black residue with a high carbon content, hydrogen, oxygen, potassium, sulphur and nitrogen. The high carbon content, resulting in a high and steady burning temperature, coupled with the cleanliness of the fuel, led to the use of charcoal as a fuel in the metal working (production and smelting) process and also in the production of glass.

The process was first described in the English language by John Evelyn in his *Sylva* dated AD 1664. Before that, however, in the third century B.C. the Greek Philosopher, Theophrastus, discussed the virtues of a number of species of trees for making charcoal for various purposes. Theophrastus also concisely described the basic method for making charcoal as follows:

> "They cut and require for the charcoal-heap straight smooth billets: for they must be laid as close as possible for the smouldering process. When they have covered (with sods) the kiln, they kindle the heap by degrees, stirring it with poles. Such is the wood required for the charcoal heap." [(3)]

The process for the production of charcoal appears to have varied little until the advent of metal kilns in the late 19th century. The process for the production of charcoal summarized below is drawn from recent experimental burnings, which themselves have drawn on evidence from the recent past [(3), (4)].

A circular or subrectangular pit was excavated. In the Wrye Valley in England, the charcoal burners preferred sandy soil to clay soils, due to the lower moisture content of the former [(3)]. Large stones were removed; due to their high moisture content, they could have exploded. This pit was then loaded with timber. Historical evidence suggests that secondary timbers rather than primary timbers were used in the production of charcoal. The timbers were piled around a central stake, known as the mottle peg [(4)]. This was removed when staking was complete, leaving an aperture through which embers were placed to fire the pile. The timber would have then been covered in straw or bracken and a layer of earth, and possibly turf, was laid over the whole pile. The mottle peg was removed, burning embers introduced, and the top of the aperture sealed. The introduction of fire into the centre of the pile enabled the fire to start in the centre of the pile and be drawn out to the edges of the pile. The burn was controlled by strategic piercing of the covering of the clamp, and allowing the penetration of air. The same method was used to introduce water into the pile to put out the fire. Water was introduced down these holes, which were then sealed. The steam would gradually put out the pile, while keeping the charcoal relatively dry. The charcoal would then have been extracted.

The pile required continuous supervision until the burn was completed. Repairs in the seal of the pile, caused by shrinkage of the wood, would have to be made. In more recent times, wood colliers or master burners would have lived in temporary hut or cabins in the woodland. As charcoal burning, like iron working, was transient by its very nature and occurred mainly in isolation away from settlement, many of the other elements of the charcoal burning process leave no trace in the archaeological record. Evidence from the excavation record does, however, provide evidence for a link between charcoal production and primary iron working.

On the Heath-Mayfield Scheme, the remains of charcoal piles have been excavated by the author at Cappakeel 2 (Licence Number 03E1048) and at Jamestown B (Licence Number 03E0623: Dempsey in prep). The example at Cappakeel 2 was dated to CAL AD780 – AD1000 (Laboratory Number Beta 201041), while Jamestown B was dated to CAL AD970 – AD1190 (Laboratory Number Beta 201022). On other schemes, examples have been excavated at Ardnamullen 1, Hardwood 2 and Hardwood 3, County Meath (Licence Numbers 02E1147, 02E1141; Murphy D, 2003A, 2003B, 2003C) and at Griffinstown, County Westmeath (Licence Humber 02E1144; Linnane, 2003). These sites were excavated in advance of the Kinnegad-Enfield-Kilcock By-pass. A charcoal pile at Hardwood 2 has been dated between CAL AD1020 and AD1210 (Murphy D, 2003B).

Such features have also been identified in Continental Europe, where, in addition to the subrectangular types, subrounded and suboval variants have also been excavated (Pleiner 2000 122 - 125). These have been dated from the Iron Age to the Medieval Period (*ibid*).

The lack of oxidization on the base and sides of C302 mitigates against the fill of this feature resulting from *in situ* burning. The slippage layer (C308) may indicate that this pit was open for a time before it was filled in with burnt material.

The charcoal present in C303 (fill C327) probably results from the burning of a post in C327. The primary fill of this pit is likely to have resulted from natural in-wash.

The material recovered from C304, consisted of residues associated with iron working including tap slag, furnace slag, iron ore, amorphous slag and clay lining and it is suggested that they are all the residues of iron smelting (Fairburn 2004; see Appendix 3). Fairburn has further suggested that the nature if the residues indicates that they result from a shaft furnace located in the vicinity of the site (*ibid*). The lack of intense *in situ* burning or oxidation normally associated with such a furnace and the lack of furnace superstructure would indicate that C304 was not a shaft furnace but is best interpreted as an irregular pit. The well-sorted nature of the fills and the sharp boundaries between them would suggest that they have been dumped into C304, rather than resulting from *in situ* smelting.

5. CONCLUSIONS AND RECOMMENDATIONS

The features excavated at Cappakeel 3 have been interpreted as the remains of a sunken charcoal pile, two pits, and an irregular pit with a slag rich fill. The direct physical impact of the M7 Heath-Mayfield Motorway Scheme on these features has been mitigated by preservation by record.

Given the close proximity to previously excavated features in the area, it is likely that this feature forms part of the archaeological complex excavated by Audrey Gahan and Ros Ó'Maoldúin under Licence Numbers 03E0603 and 03E0633 on behalf of Valerie J. Keeley Limited as part of pre-construction excavations on this scheme.

As no suitable dating evidence could be recovered from the fills of C301, this sunken charcoal pile is undated. Given the Early Medieval dates obtained from similar features at Cappakeel 2 and Jamestown B, it is likely that C301 was also of Early Medieval date.

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6.3 Endnotes

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(2) http://www.excavations.ie/Pages/Details.php?Year=&County=Laois&id=2409

(3) http://www.wyreforest.net/Study_Group/wyreforest.netwb.html

(4) http://www.regia.org/charcoal.htm

7 APPENDICES

7.1 Appendix 1: Paper Archive

24 context sheets

4 pre-excavation plans (A3, 1:50)

4 post-excavation plans (A3, 1:50)

4 section drawings (A3, 1:10)

1 roll colour print film

7.2 Appendix 2:

Assessment of charred plant remains from excavations at Cappakeel 3, County Laois, Republic of Ireland (Licence No: 03E1724), Örni Akeret, 2004, Palaeoecology Research Services

Palaeoecology Research Services **PRS**
2004/80

Assessment of charred plant remains from excavations at Cappakeel 3, County Laois, Republic of Ireland (Licence no: 03E1724)

by

Örni Akeret

Summary

A small quantity of charred plant remains recovered from the primary fill of a charcoal manufacturing kiln during excavations at Cappakeel 3, County Laois, Republic of Ireland, was submitted for assessment. This site was encountered during works associated with the M7 Heath-Mayfield Motorway Scheme.

*All of the recovered remains were of charcoal except for one achene of buttercup (*Ranunculus *subgenus* Ranunculus*). The charcoal fragments were too small to be identified and were not suitable for radiocarbon dating.*

KEYWORDS: CAPPAKEEL 3; M7 HEATH-MAYFIELD MOTORWAY SCHEME; COUNTY LAOIS; REPUBLIC OF IRELAND; ASSESSMENT; CHARRED PLANT REMAINS; CHARCOAL

Introduction

An archaeological excavation was undertaken by Archaeological Consultancy Services Ltd (ACS) at Cappakeel 3, County Laois, Republic of Ireland, as part of works associated with the M7 Heath-Mayfield Motorway Scheme.

The site consisted of a charcoal manufacturing kiln which was sub-rectangular in shape with rounded corners. The base (Context 305, from which Sample S2 was recovered) was heavily oxidised and overlain by a charcoal rich fill and a layer of backfill.

Small quantities of charred plant remains, recovered from the single bulk sediment sample, were submitted to Palaeoecology Research Services Limited (PRS), County Durham, UK, for assessment.

Methods

The sediment sample was processed by ACS prior to delivery to PRS, and the small quantity of charred plant remains recovered submitted for assessment. The excavator's standard processing technique was employed. The soil sample was placed onto 1 mm nylon mesh in a sieving tank. The light organic fraction was washed over through a 2 mm sieve into a 500 micron sieve to collect the flot. The soil sample was put through this system twice to ensure that as much material as possible was recovered.

Plant remains were submitted for identification and for consideration as the basis for radiocarbon dating by standard radiometric technique or accelerator mass spectrometry (AMS).

Nomenclature for plant species follows Stace (1997). The identification of charcoal follows Schweingruber (1978).

Results

Context C305 [base of charcoal manufacturing kiln]
Sample S2
The sample consisted of charcoal fragments that were too small to be identified. The only plant remain apart from charcoal was a single achene of buttercup (*Ranunculus* subgenus *Ranunculus*).

Discussion and state of potential

The charcoal fragments from Cappakeel 3 are too small to be identified and are not suitable for radiocarbon dating.

With a few exceptions individual species of buttercup (*Ranunculus* subgenus *Ranunculus*) cannot be identified on the basis of achene morphology. The various species occur in a wide range of habitats rendering this taxon of no value for environmental reconstruction.

Recommendations

No further work on this material is warranted.

Retention and disposal

All of the recovered remains should be retained as part of the physical archive for the site.

Archive

All material is currently stored by Palaeoecology Research Services (Unit 8, Dabble Duck Industrial Estate, Shildon, County Durham), along with paper and electronic records pertaining to the work described here.

Acknowledgements

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7.3 Appendix 3: Assessment of Industrial Residues from Excavations at Cappakeel 3, Co. Laois, Licence 03E01724, Neil Fairburn for ACS Ltd. July 2004

Assessment of Industrial Residues from Excavations at Cappakeel 3, Co. Laois. Licence 03E01724

Neil Fairburn for ACS Ltd.
July 2004

Summary

The excavations at Cappakeel 3, Co. Laois have produced a small, but exciting, collection of industrial residues. Cappakeel 3, can for the time being, be considered to be an important site for Irish metalworking, as it can now be added to the limited but growing evidence for the use of the shaft furnace in the iron smelting process in Ireland.

Five hundred and seven pieces of industrial residues were recovered from an isolated sub-rectangular pit during the archaeological excavations at Cappakeel 3, Co. Laois. The slag weighed a total of 7.6kg and the author examined all the pieces. The industrial residues consisted of material associated with iron working: tap slag, furnace slag, iron ore, amorphous slag and clay lining and it is suggested that they are all the residues of iron smelting.

The presence of ores and taps slags together with quantities clay lining material will now bring Scott's 1991 statement of no shaft furnaces in Ireland into question and this will now need to be revised.

Introduction

When an archaeologist excavates a site that has the remains of iron production, the assemblage of finds will mainly consist of burnt ore, charcoal, slag and fired clay. The charcoal, slag and clay form integral and inseparable parts of the metallurgical process. This inevitably means that to understand the site, firstly it is necessary to identify and interpret the slag and burnt clay remains, and secondly one has to understand the basic technology of iron production that has produced the assemblage.

The manufacture of an iron artefact from iron ore can be separated into three distinct processes. The smelting of the ore in a furnace, which will produce a bloom of iron as well as fayaltic slag residues; the primary smithing consolidation of the iron bloom into a billet; and finally secondary smithing - the shaping of the billet into an object. Each of these processes will produce a range of residues.

Work by Brian Scott (1991) has indicated the range of material that might be found on early ironworking sites in Ireland, and recent work by Peter Crew and Thilo Rehren on material from the excavations at Ráith Na Ríg, Tara, Co. Meath has highlighted the types of industrial residues that are diagnostic of both iron smithing and non-ferrous metalworking (Crew and Rehren 2002). However, aside from this recently published work, very little analytical work has been carried out on early Irish ironworking sites. Edwards (1996) notes that in past excavations in Ireland the slag was often not recorded systematically or rarely analysed to provide additional information about the activity that produced it

Experimental and analytical work on iron production and iron working residues in Britain, particularly work by Peter Crew, Snowdonia National Park, at Bryn y Castell, Crawcwellt and Llwyn Du, Wales, (Crew 1986, 1989, 1990, 1991, 1998, Crew and Crew 1995) and Gerry McDonnell, Bradford University (1988), along with work in Europe by Radomír Pleiner (Pleiner 2000), has clearly shown the nature of the archaeological evidence for iron production and for secondary smithing, and archaeologists can now identify the range of metalworking activity on sites in Ireland and Britain more confidently.

The Ironworking Process

The base material for making iron is ore. Any iron ore needs to have a sufficient concentration of iron minerals for conversion to metallic iron, but the reducibility and availability of ore will influence the willingness to use lower-grade ores. Therefore it is reasonable to accept that mineral composition, both of the iron mineral, the location and availability of ores had the most influence over the production of iron.

The commonest iron ores in a geological sense are hematites, limonates and carbonates. The largest concentration of these iron ores in Ireland is in County Wicklow (Scott 1991, 153-154). However, one of the major sources of iron ore and the most likely to have been used for iron smelting in Ireland, was bog ore. A relatively easy ore to extract once it had been located. In theory there are plenty of sources of bog ore around Ireland, but this aspect has not been studied but is often cited. An analysis of the iron working slags recovered from the rath at Mullaghbane, Co Tyrone (Harper 1972) and the ringfort at Cush, Co Limerick (O'Riordain 1940) showed that bog ore was used on these sites for the manufacture of iron.

Before it was smelted, it was necessary for the mineral ore to be broken into smaller fragments and roasted to drive off excess water and also to change the ore to an iron oxide. On most sites, the roasting of the ore would have taken place in a simple bonfire on to which was heaped the iron ore and a bonfire erected around it. This may have taken place close to the furnace, but equally may have taken place near to the ore source.

Ore and fuel, usually charcoal, are fired in a furnace in a reducing atmosphere to remove unwanted material (the slag) and produce raw iron. The furnaces were either a shaft furnace or a bowl furnace. The air-supply for the burning fuel is provided by forcing the air through blowing holes in the sides of the furnace with use of bellows, or by natural draught as has been proposed for the medieval furnaces at Stanley Grange, Derbyshire (Challis 2002).

Shaft furnaces could have been up to 1.5m tall and some 0.30m in diameter and were built with clay. Considerable quantities of clay would have been used in the construction of furnaces and it could have been an important aspect in the location of a site. It is the large quantity of the vitrified remains of the furnace superstructure that helps to identify the remains of a shaft furnace.

At the base of the majority of the shaft furnaces was a small arch that enabled the slag to be removed. The efficiency of the shaft furnace improved in Britain with the arrival of the Romans, who went on to industrialise iron producing areas like the Weald (Cleere and Crossley 1986), using efficient large furnaces similar to the one found at Laxton (Jackson and Tylecote 1988 and Crew 1998a). For example, the known

Roman sites in the Weald produced tens of thousands cubic metres of slag and tonnes of iron (Cleere and Crossley 1986).

The Post Roman period in Britain has produced no evidence to suggest great centres of smelting comparable with the Roman occupation (Cleere and Crossley 1986, 87). The evidence that can be gathered suggests that the Roman metallurgical techniques for smelting iron were not passed onto the native population of Britain (Tylecote 1986, 179). Instead the evidence suggests that the native population returned to a pre-Roman Iron Age tradition of producing iron probably with smaller shaft furnaces. The two possible explanations Tylecote (1986) give for this are that the old techniques were reintroduced by the migration of peoples from north east Europe and more likely- the economic conditions did not warrant the same large scale production as the Roman period did. The main notable development, however, in the medieval period in terms of iron production, comes later with the introduction of waterpower in the fourteenth century (Cleere and Crossley 1986,106).

The shaft furnace was loaded from the top with alternate layers of iron ore and charcoal. Molten slag was drawn off through an arched opening at the bottom and ran away in channels in which it solidified. The arched opening allowed air to be drawn into the shaft but bellows could also be used. Shaft furnaces achieved a higher temperature, so increasing the carbon content of the iron and also could produce larger amounts of iron.

During smelting the iron minerals are reduced and broken up by reaction with the burning charcoal. The unwanted minerals and elements, of which silicon is the most important, react with part of the iron oxides from the ore and with the clay and fuel ash form a liquid slag that falls to the bottom of the furnace. The clay used in construction of the furnace and possible air-pipes is subjected to the high furnace temperatures as well. If sufficiently heated it may melt, resulting in vitrified clay, or is even dissolved into the slag.

The final product of smelting, besides the residues of ash and slag, is called a bloom. This is a rough, oftenspongy mass, containing metallic iron flakes and nodules that have sintered together, mixed with bits of slag, partially reduced ore, charcoal and parts of the furnace clay. The bloom gives the early production technology its name of "the bloomery process".

The bloom has then to be refined. This is done by hammering the bloom into a smaller piece, consolidating the iron particles and this is part of the primary smithing process.

Primary smithing requires that the iron bloom is heated again until red-hot and soft, and subsequently hammered to squeeze out remaining slag and consolidate the fragment into a workable shape. This piece of iron, called a billet, can then be worked on again and made into an artefact. The slag that is squeezed out during the primary smithing of the bloom will end up in the bottom of the hearth, and it differs from smelting slag in that it is more or less magnetic and less fluid. These slags forming just above the bottom of the hearth are very characteristic and are often described as smithing hearth cakes or more frequently as

Plano Convex Bottoms (PCB's). These slags are sub-circular convex-convex shaped and usually magnetic. The smithing process hardly changed from the Prehistoric period through to the medieval period, leaving similar residues.

The smithing of the bloom can be done anywhere. Quite often this primary smithing was carried out on the smelting site. The bloom is heated in a hearth or forge. The hearth doesn't need a purpose built structure but would require a shelter from the elements for the smith and also so as to provide low light for the smith to be able to judge the temperature of iron. Early ironworking hearths were situated at ground level, while some Roman, and later, medieval, hearths were positioned at waist height. The anvils, positioned close to the hearth, to strike the red hot bloom quite often utilised a large flat topped stone or a large wooden block.

The hammering of the metal bloom produces further waste products; slag spheres, solid balls or vesicular balls of slag that can fly for a considerable distance; hammer scale, small flat and thin pieces of magnetic metal. Hammer scale is usually a prime indicator of smithing and can be used to locate where the process was taking place. However hammer scale can also be produced during the consolidation of the bloom,

If a large amount of smithing has taken place, the residues from this process can become trampled in to the floor around smithing area and form a cemented smithing pan. The pan is a conglomerate of highly magnetic material, dust, hammer scale, slag spheres and some other non related material.

Secondary smithing is the process that turns a refined billet into an artefact or implement and is carried out in the same way as the primary smithing and leaves the same sort of residues described above. This is the sort of small scale smithing work is the sort of work that would be expected to be undertaken within the small nucleated farmsteads and enclosures. It has been suggested that many people were using basic iron technology to make and repair simple artefacts (secondary smithing), but the actual production of iron and manufacture of complex iron artefacts were still being produced by specialised smiths (Mytum 1992). Documentary evidence from the Irish Annals suggests that the blacksmith was held in high esteem and that the forge was a central part of the community (Scott 1987, Edwards 1996, 86).

Quantification of the industrial residues from the excavations at Cappakeel 3.

Context Number	Description	Qty	Weight grammes	Comment
C318	Tap Slag	14	662	1 piece 273g
C318	Amorphous Slag	85	912	
C318	Vitrified Clay Lining	4	87	
C318	Clay Lining	37	409	
C318	Ore	2	4	
C318	Unreduced ore and slag	1	34	
C319	Clay Lining	1	113	
C319	Vitrified Clay Lining	27	337	
C319	Amorphous Slag	95	775	
C319	Viscous Slag (Tap Slag?)	4	94	
C319	Tap Slag	38	1107	2 pieces 256g
C319	Furnace Slag	2	226	
C319	Unreduced ore and slag	2	58	
C322	Vitrified Clay Lining	15	273	
C322	Amorphous Slag	110	798	of which 5 pieces weighed 305g
C322	Clay Lining	8	30	
C322	Furnace Slag	1	244	
C322	Viscous Slag (Tap Slag?)	42	519	
C323	Amorphous Slag	8	209	
C323	Viscous Slag (Tap Slag?)	1	227	
C324	Tap Slag	1	136	
C324	Vitrified Clay Lining	2	167	
C324	Amorphous Slag	7	158	
Total		**507**	**7579**	

Amorphous slag

As with most assemblages there is a quantity of material that is difficult to classify and is termed 'amorphous'. Amorphous slags do not have any distinguishing characteristics and are amorphous in shape and are often small. They could be from either the smelting or the smithing process, but it is more likely, as no diagnostic smithing slag was found at Cappakeel 3, that they are from the smelting process.

Tap slag

Characteristic finds from iron smelting sites dating from late prehistoric times up until the 15th Century are pieces of slag with flat rounded bottoms and contorted upper surfaces with flow patterns. These are known as tap slags. The molten slag was drawn off through an arched opening at the bottom of a shaft furnace and ran away in channels in which it solidified. Tap slag has a characteristic ropey shape resembling a flow of lava. This type of slag represented the largest quantity of material recovered from the Cappakeel 3 excavations.

Furnace slag

The furnace bloomery slag is usually represented by the largest amount of material recovered by weight from a smelting site, which is not surprising as these slags are usually large and heavy. The quantity of these slags produced from the furnace is usually dependant on the scale of the smelting and on the quality of the ore (Crew 1991). However, at Cappakeel 3 only a small quantity was recovered. The furnace slag was fayalitic, slightly fluid looking and magnetic. It is likely, owing to its shape that this slag formed in the bottom of a furnace.

Clay Lining

This material consists of an oxidised orange clay, from the high temperature, tempered with small refractory pieces of quartz.

Vitrified Clay Lining

This material consists of clay that has been vitrified on one side in the high temperature area of the furnace or the smithing hearth. Vitrified lining is produced by a high temperature reaction between the clay lining and the alkaline fuel ashes or slag

It can be difficult to identify if pieces of vitrified clay come from a furnace or a hearth structure. Smelting sites usually produce significantly larger quantities than smithing sites, because of the difference in the size of the structures.

The lining appears to have been made from the local clay and has oxidised to a orangey red colour. Where one face of this lining has been exposed to high temperatures, it has started to vitrify to a slightly vesicular vitreous material. This vitrified surface varies in colour on different fragments from black through to olive green, which in turn reflects the temperature conditions. One piece of vitrified lining shows that it has been tempered with quartz.

Feature C304

This feature was a large irregular feature *c*.2.2m long, *c*.1.7m wide and *c*.0.8m deep. It was initially interpreted as a tree pit that had been backfilled with waste from the iron working processes. It contained no evidence of *in situ* burning and the industrial residues appeared to have been deposited in a series of layers. As slag is a waste product it is not surprising that it has been used to back fill a hole.

The lack of *in situ* burning would indicate that the feature was not used for iron working. However, the shape of the feature seen in section does appear to show what could be interpreted as a base of furnace with a tapping pit in front of it, but the lack of charcoal and burnt material in the base of context C.326 and *in situ* burning and charcoal in C.308 and the lack of a structure around the possible furnace also does not support this.

It is possible as the full extent of the feature was not uncovered; as it lay beyond the edge of the road take, that the feature could extend and be part of the iron working process. Further investigation of this area is needed to prove this.

Feature C301 – Charcoal Manufacturing Kiln

The location of this feature, which has been interpreted as charcoal manufacturing kiln, close to an ironworking site demonstrates that the processes required to manufacture iron were all located in close proximity to one another. Charcoal was an important constituent of the ironworking process.

Smelting sites are usually located close to the resources that are required to produce the metal. Any ironworking site should be close to the ore source, wood for the charcoal and clay for the furnace lining, as transporting the raw materials from one place to another would have been a waste of time and effort. Peter Crew has made an approximate calculation that to produce 1kg of iron with a shaft furnace; ancient smelters would have needed some 15kg of ore, 100kg of charcoal and this would have taken 25 man days work (Crew 1991).

In comparison, Tylecote's experiments with a bowl furnace, undertaken in laboratory conditions, which bear no relation to actual field conditions, estimated that it would require 5-7kg or ore and 60kg of charcoal, but did not quantify the required man days work (Tylecote 1986, 133). These experiments are discussed further later in the report.

Discussion

The only certain indications for an iron smelting site are primarily the presence of ores and tap slags and also the presence of pieces of the furnace superstructure. Without either of the two reliable indicators, a site should be considered to be an iron smithing site. Slag is not datable in itself, but it is an important indicator of the site activities. At Cappakeel 3 only a relatively small quantity of slag was recovered from a irregular feature, from which the presence of tap slag and ore was noted.

The small quantity of material found at Cappakeel 3 would not be indicative of large scale production which could be associated with trading, as there are insufficient quantities of slag. However, as the feature that contained the slag was on the edge of excavation area, it is possible that further deposits of slag and iron working features lie in the area beyond this.

The tap slag is a likely indicator that an iron smelting activity was located in proximity to the pit. As tap slag finds in Ireland are unusually rare, their presence at Cappakeel 3 in an archaeological context is noteworthy and they should be recognised as coming from a probable iron smelting site that was using a slag tapping shaft furnace.

To summarise this, the material recovered from the irregular feature at Cappakeel 3, indicates that iron smelting was taking place, probably using a shaft furnace, but no remains of the furnace superstructure was found. It is possible that the subrectangular feature was the now destroyed remains of a shaft furnace as the slag was found in the base of it, but unfortunately the lack of other evidence does little to support this.

Further follow up work at Cappakeel 3 would be useful in attempting to pinpoint the extent of the metalworking site, if there is one, and look for the characteristic dump of waste slag. Ideally if at all possible this should be done with a combination of non-invasive geophysics and perhaps augmented with trial trenching. Work by Peter Crew *et al* has shown the benefits of using geophysics to pinpoint metalworking sites and also to obtain archaeomagnetic dates from them (Crew 2002 and Crew, Smekalova and Bevan 2002).

Cappakeel and Ironworking in Ireland

The ironworking debris material recovered from Cappakeel 3 was not large and it is impossible to say how many episodes of iron smelting have taken place. Experimental work has shown that the iron smelting process, to produce a bloom, followed by its smithing, would be expected to produce a lot more slag waste, with at least 7kg of slag waste per episode from a small shaft furnace (Crew 1991).

The low quantity of material from Cappakeel 3 and the lack of a permanent site with structures would either suggest that the demand for the iron was short lived, perhaps suggesting some urgency for its production or that the material has been removed at a later date or it is still waiting to be found outside of the excavation area. It may even support the idea of Mytum (1992) that some of the Early Medieval ironworkers were itinerant workers and moved on from place to place, suggesting perhaps that Cappakeel 3 was just a spot where a small quantity of iron was produced for a local market.

It is also possible that the ironworking material from Cappakeel 3 may be associated with the archaeological complex uncovered during the pre-construction archaeological assessment phase (Licence 03E0603 and 03E0633). Details of these excavations were not available for consultation for this report.

The amount of slag on a site can provide information about the metal working processes taking place. The 7^{th} –8^{th} century ringfort at Lisleagh, Co. Cork produced over 800 kg of slag (Scott 1991, 158). Later, Roman and Medieval sites in Britain can have upwards from one tonne to hundreds of tonnes of slag. Many of these later slag heaps were huge and may once have been larger still.

Early shaft furnaces and even later Roman furnaces in Britain are now known to have been inherently inefficient, as also was the material produced in bowl furnaces in Ireland. The slag from these early iron working sites still remained rich in iron and this was often plundered for re-smelting during the 18th and 19th centuries. It was also used in road-building and sometimes even for manuring to aid soil drainage.

A large number of smelting furnaces have been identified in Ireland and Britain, most of which are in Britain and are of the shaft type with provision for slag-tapping, whereas in Ireland the only smelting furnace identified has until recently been the bowl furnace.

As Scott wrote in 1991, "the principle difficulty in interpreting ironworking structures on Irish sites is the probability that hemispherical hole in the ground showing evidence of intense heat is as likely to have resulted from smithing as from smelting or even a combination of both". Unfortunately this is still the case twelve years on, with very few ironworking sites in Ireland studied in any depth and disseminated through publication. Therefore it is difficult to find comparable sites from published sources on work in Ireland with the exception of the influential work by Scott (1991). Ironworking residues seem to be dismissed by archaeologists as 'its just slag and we know all about this from Brian Scott's work'.

A bowl furnace has been described by Scott and Tylecote (Scott 1991 and Tylecote 1986) as a furnace consisting of an open or possibly covered bowl-shaped depression in the ground, which may or may not be lined with a clay ceramic or a layer of refractory stones. Bowl furnaces are currently, through the work of Scott, thought to be the only type of furnace that was used in Ireland from the Iron Age through to the Medieval period (Scott 1991, Pleiner 2000). There is some debate as to whether or not the bowl furnace could function properly to produce a large quantity of iron for a sizable iron bloom. The iron blooms which have been found so far in Ireland, like Carrigmurrish Cave and Brothers' Cave in Co. Waterford (Scott 1991, 162), are too big to have come from a bowl furnace, indicating that larger furnaces of the shaft type were probably used.

Tylecote's experiments have shown that bowl furnaces had similar charges of ore and charcoal like the shaft furnace, but these were placed vertically on the side of the furnace, opposite the tuyère-blowing hole. The slag then ran downwards and consolidated into a disc like lump of slag (furnace bottom) or even formed on the side of the hearth below the tuyère. The iron bloom then formed on top of the slag. The conglomerate of slag and iron was removed by lifting it from the top. Tylecote showed that it would then have been necessary to break this conglomerate up to separate the iron from the slag and then it was reheated to form a small bloom.

Characteristic finds from shaft-furnace sites are large pieces of furnace lining and pieces of slag that have solidified in the channels and so have a rounded bottom and a contorted upper surface with flow patterns and these are known as tap slags. It is the absence of these tap slags and large quantities of clay furnace structural evidence from sites in Ireland, which has led to Scott (1991) and Pleiner (2000) to suggest that the shaft furnace was not used in Ireland during the Irish Iron Age and Medieval period. Scott suggests that the lack of innovative technology was blocked by socio-political developments and subsequently poor communication between craftsmen in Ireland and with Britain (1991, 213-214).

Excavations on Irish sites have turned up a number of the so-called curved furnace bottoms, which are believed to have come from the bases of bowl furnaces. It is more likely that that these furnace bottoms are in fact smithing hearth plano-convex bottoms (PCB's) and that the sites were actually iron smithing sites rather than smelting and the 'bowl furnaces' were in fact smithing hearths. This would at least explain the lack of tap slag and furnace lining material. However, the material from these sites needs to be re-examined with the benefit of the recent work by Crew and McDonnell before this can be confirmed.

The bowl furnaces from Irish sites where smelting has been confirmed are probably but not exclusively the remains of low shaft furnaces. Tylecote's experiments with bowl furnaces found that they were much more successful if the bowl was actually enclosed with a dome or a low shaft. This type of furnace would have allowed the bowl to have a large diameter and the shaft or dome would have produced the necessary reducing conditions to smelt a reasonable quantity of iron. The slag from this furnace is unlikely to have been tapped and the bloom would have to have been brought out through the top of the structure or the structure was broken open to obtain the bloom. If the structure was broken it might explain the lack of lining structure around the feature, as this material would have been more widely dispersed rather than concentrated in one area after the furnace was abandoned.

Bowl furnaces associated with iron smelting have been identified by O'Kelly at the ringfort of Garryduff 1 and at Ballyvourney Co,Cork, The furnaces on these sites were small pits, lined with clay into which the charcoal and iron ore would be placed. The slag was not tapped but formed in the bottom of the furnace, while the metallic iron was left to form a bloom (O'Kelly 1952 and 1962).

Evidence of iron smelting during the Early Medieval period is known from other sites besides Ballyvourney and Garryduff 1. These include Garranes, Co. Cork (O'Riordain and Hartnett 1943), Laithmore, Co.Tipperary (Tylecote 1986, 188), Lagore Crannog, (Hencken 1950) Clogher (Scott 1983), the ecclesiastical centre on Church Island, Co Kerry (O'Kelly 1958).

Iron working slag has also been identified in County Laois at the Early Iron Ages site at Ballydavis (Keeley 1999). Excavation at Ballydavis uncovered a group of circular features between 0.55m and 2.2m in diameter. These circular features are believed to be bowl furnaces, and were located along with slag, crucibles and glass artefacts. The range of material at Ballydavis is similar to that from Tara (Crew and Rehren 2002) and Ballydavis may not actually be an iron smelting site.

Examination of iron working material from recent excavations along the route of the M4 motorway between Kilcock, Co Meath and Kinnegad, Co. West Meath has indicated that the majority of the recovered material was from the smelting of iron in bowl furnaces, with sites dating between the Iron Age and the Early Medieval period (Photos Jones 2003).

More recently, excavation work in County Kerry has uncovered definite evidence of the use of a shaft furnace for the production of Iron in Ireland at Ballydowney and Farrananstack (Fairburn 2003a and

Fairburn 2003b). The evidence from these two sites and also now from Cappakeel 3 combined with the blooms from Carrigmurrish Cave and Brothers' Cave in Co. Waterford will now bring Scott's 1991 statement of no shaft furnaces in Ireland into question and this will now need to be revised.

It does seem bizarre that the innovative technology of the shaft furnace was being employed a short distance away across the Irish Sea and yet with clear evidence of trade and raiding between Ireland Britain during the Iron Age through to the Early Medieval period, that this efficient method of iron production was not brought to the Irish Blacksmith. The later arrival of the Hiberno Norse with their metallurgical traditions should also have brought this technological advance on the bowl furnace to the Irish shores, likewise with the Anglo – Normans. Yet the myth persists that the shaft furnace was not used in Ireland and only the bowl furnace was employed.

Cappakeel 3 joins the small but growing list of sites in Ireland where it can be shown that the shaft furnace was in use and proves that it was brought to Ireland. Additional sites will eventually be recognised as more excavated industrial residues are studied and excavators become more familiar with the products of iron working technology.

Conclusion

The excavations at Cappakeel 3 have produced a small amount of industrial residues from the iron working smelting process. This material has provided additional evidence, substantiating the use of the shaft furnace in the production of iron in Ireland.

It is clear that this site will eventually make a major contribution to our understanding of the cultural sequence of the metalworking in the region and in the country. The well stratified nature of the deposits and, indeed, the presence of directly datable residues with the ironworking slag will allow this assemblage to be used by researchers in the future in a much more meaningful way than has previously been possible.

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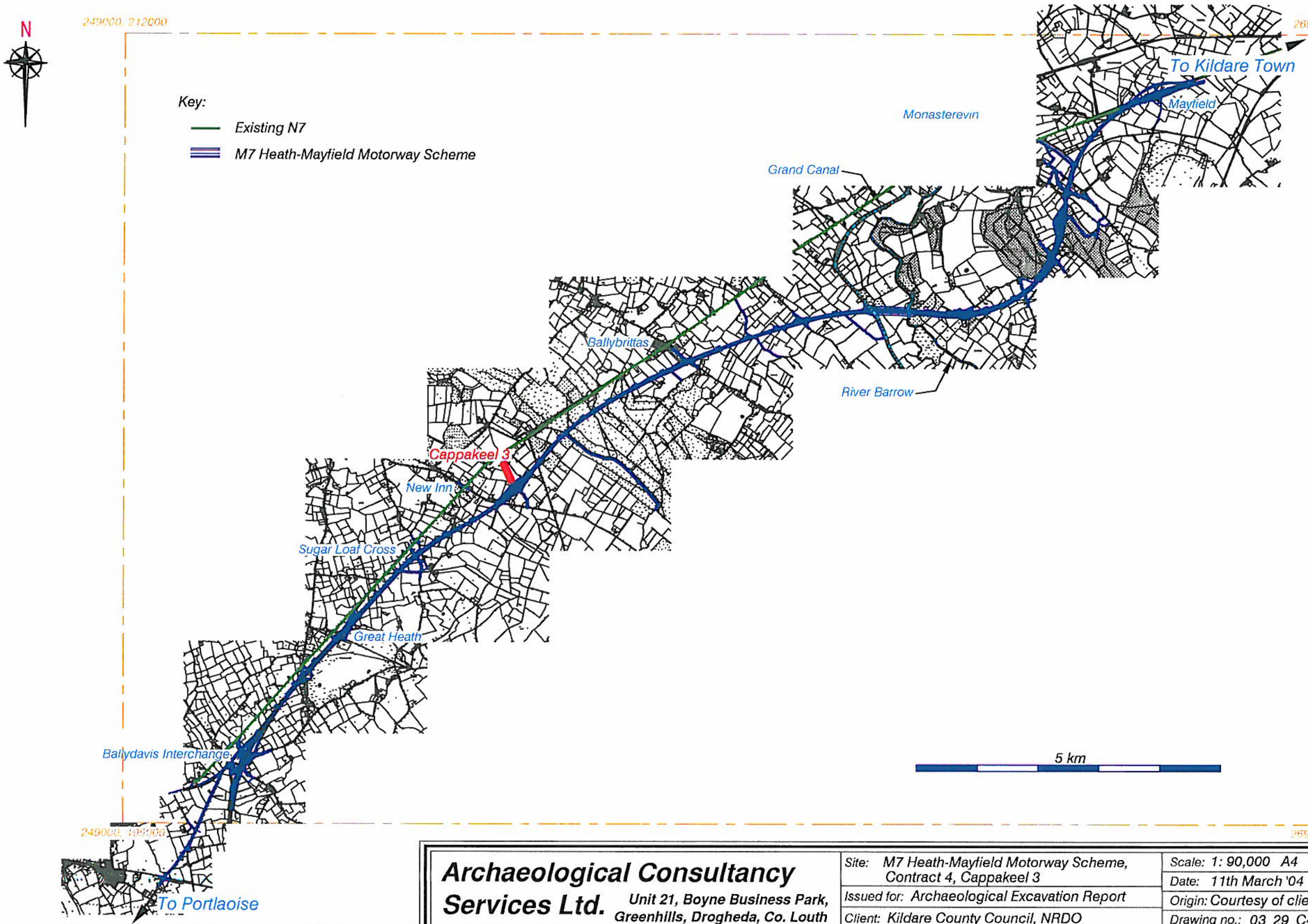
August 2005



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		Origin: Courtesy of client
	Client: Kildare County Council, NRDO	Drawing no.: 03_29_C40

Figure 1: Location of the M7 Heath-Mayfield Motorway Scheme

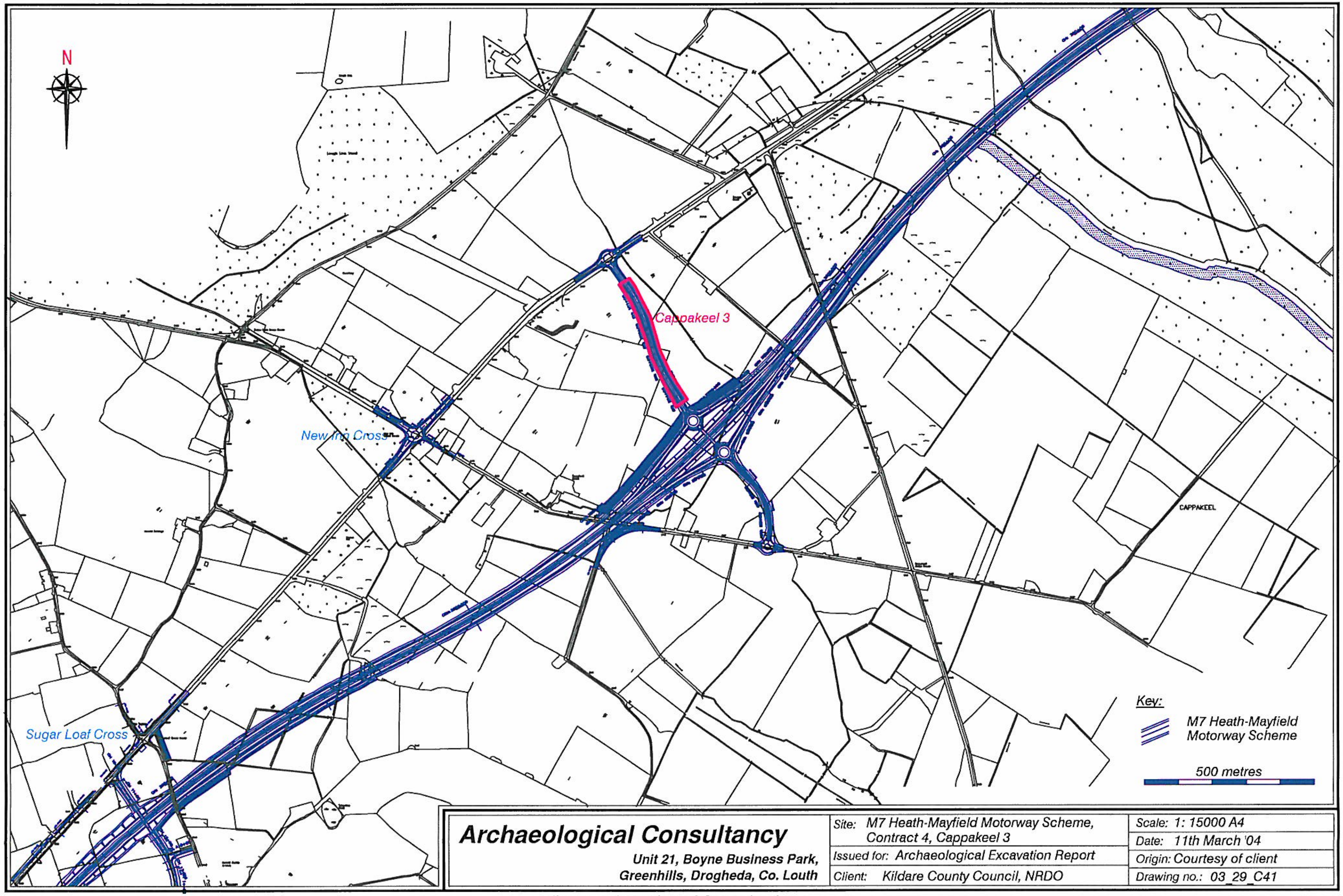
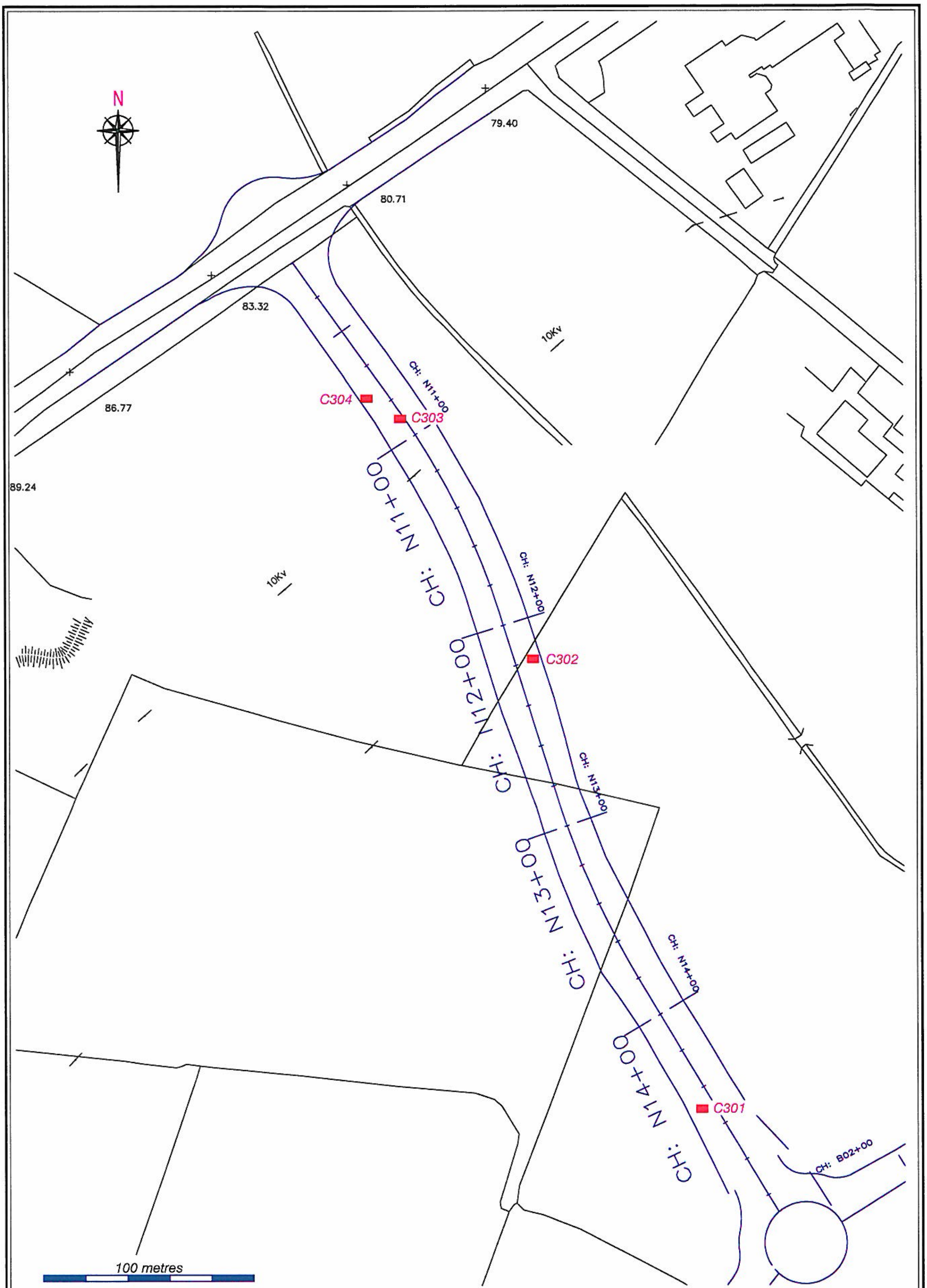


Figure 2: Location of Cappakeel 3



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		Date: 11th March '04
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	Client: Kildare County Council, NRDO	Drawing no.: 03_29_C53

Figure 3: Cappakeel 3 - Location of features

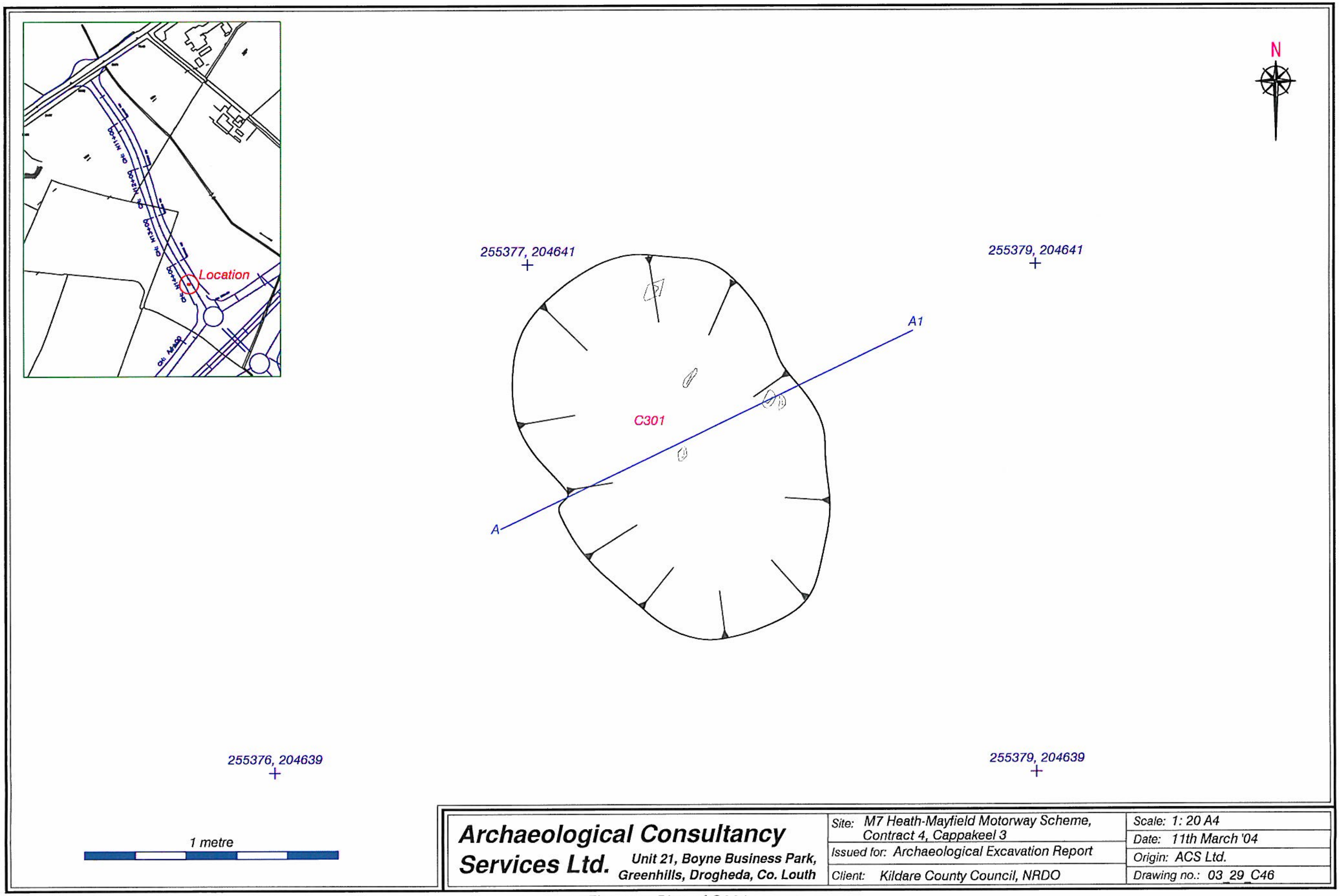
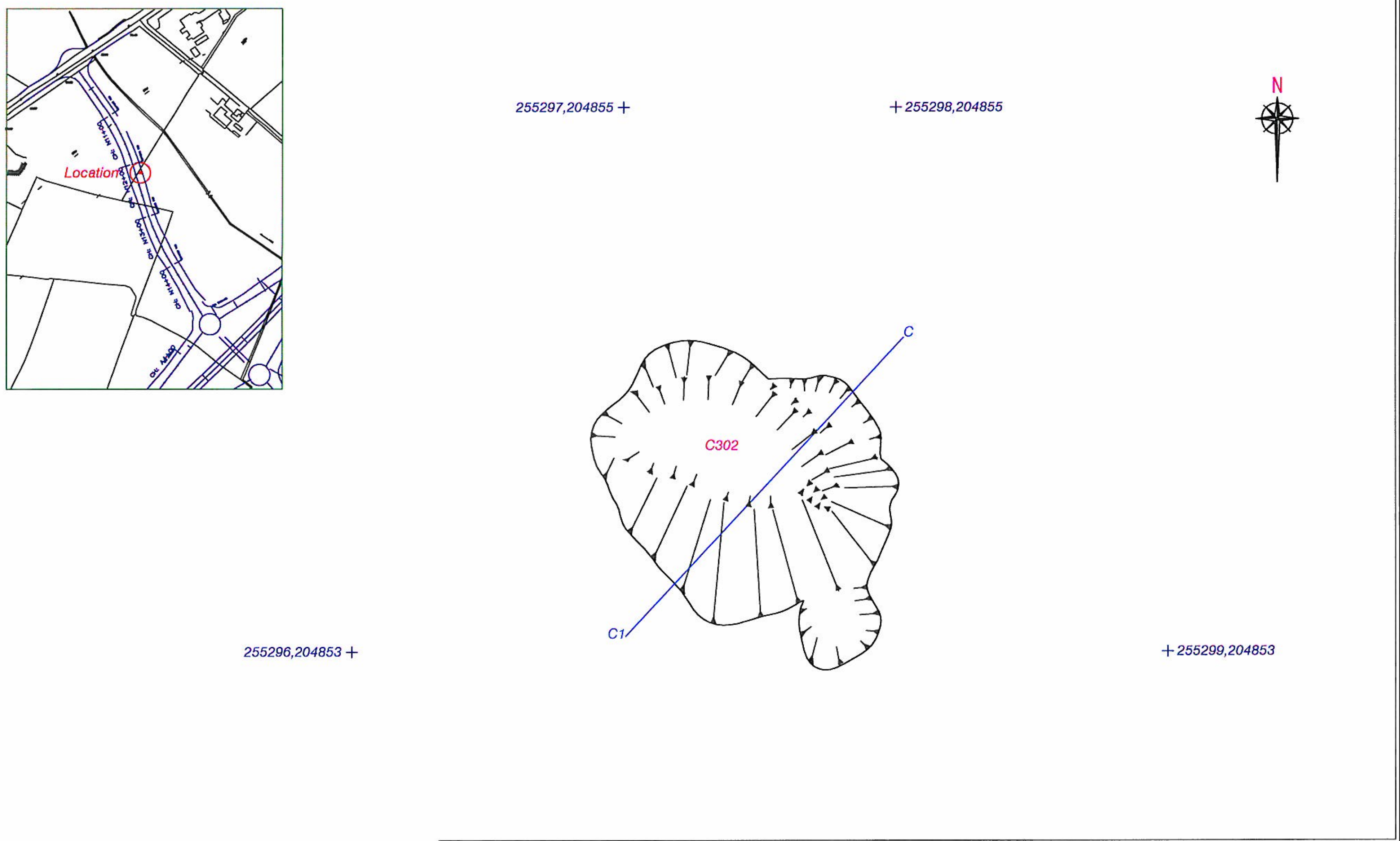


Figure 4: Plan of C301



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	Client: Kildare County Council, NRDO	Drawing no.: 03_29_C44

Figure 5: Plan of C302

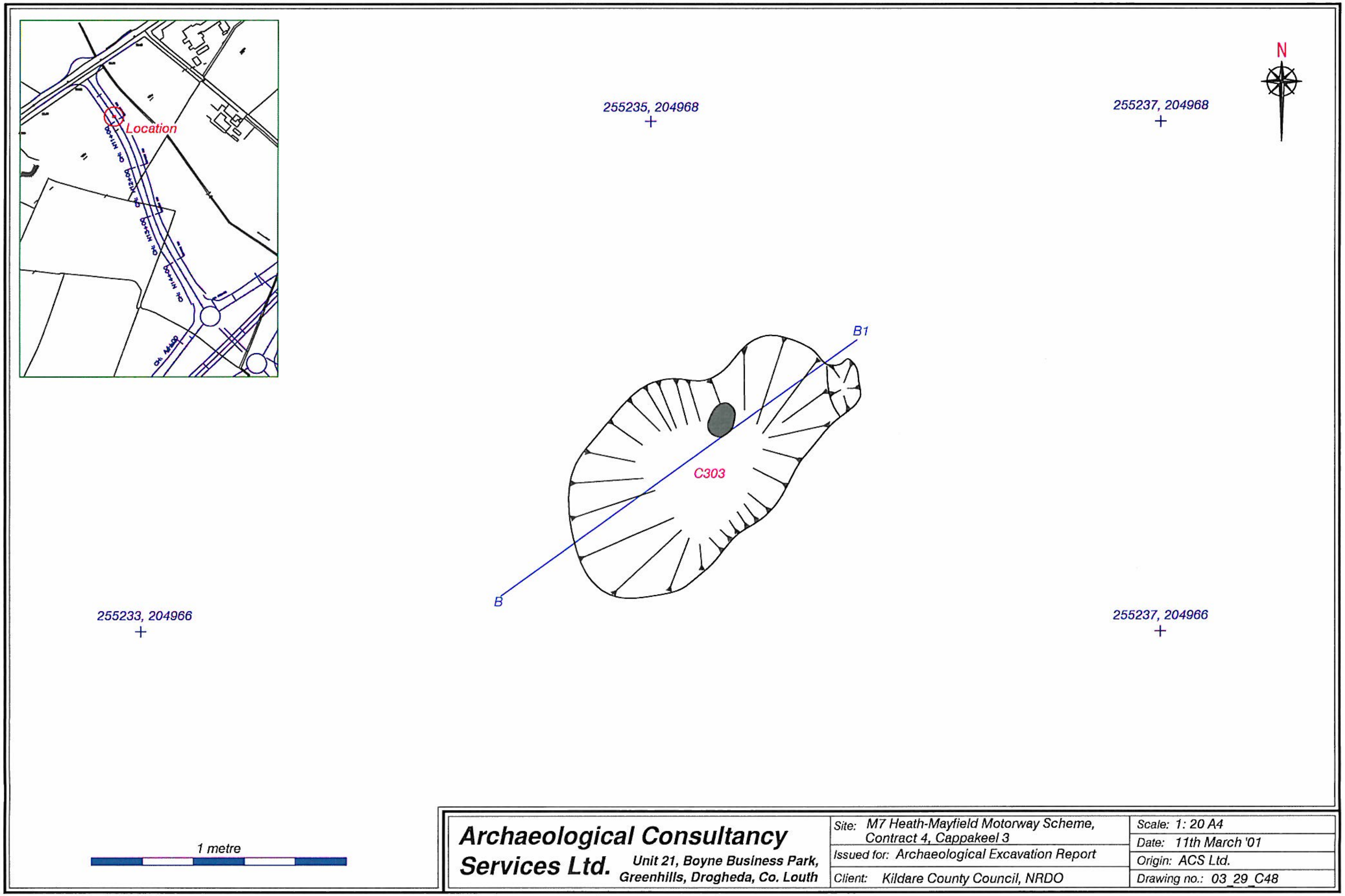
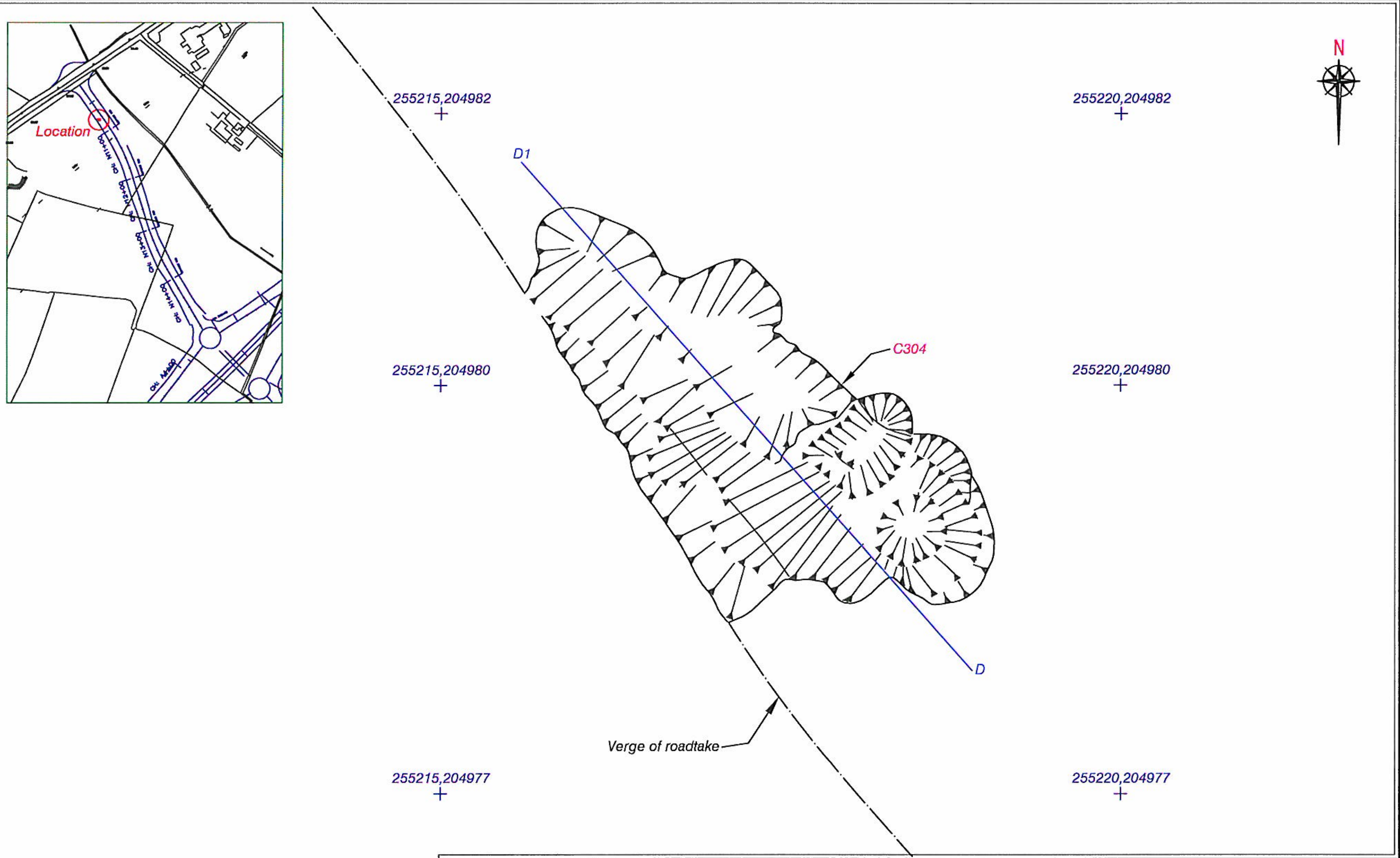


Figure 6: Plan of C303



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		Origin: ACS Ltd.
	Client: Kildare County Council, NRDO	Drawing no.: 03_29_C49

Figure 7: Plan of C304

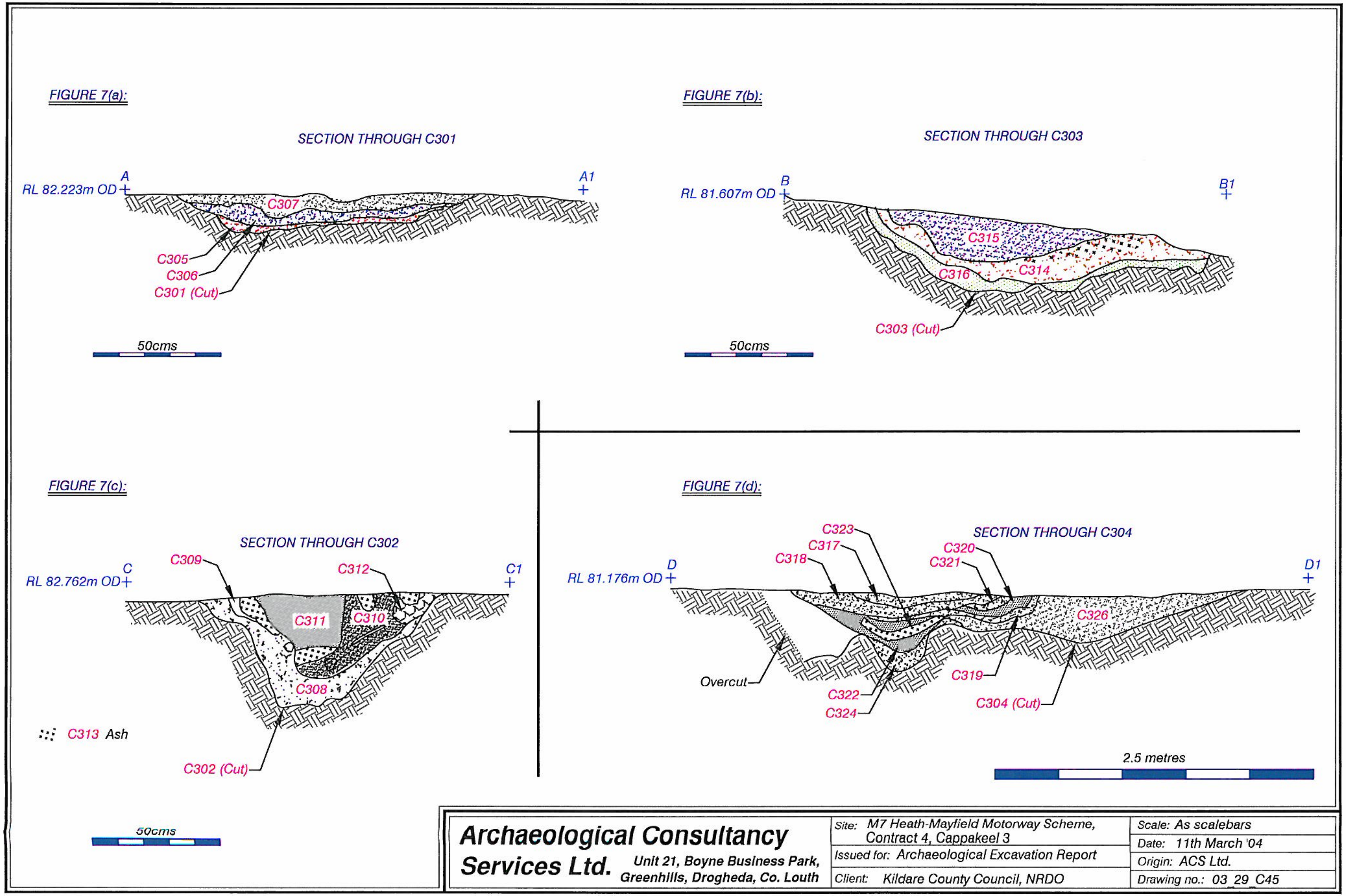

Figure 8: Sections through C301, C302, C303 and C304

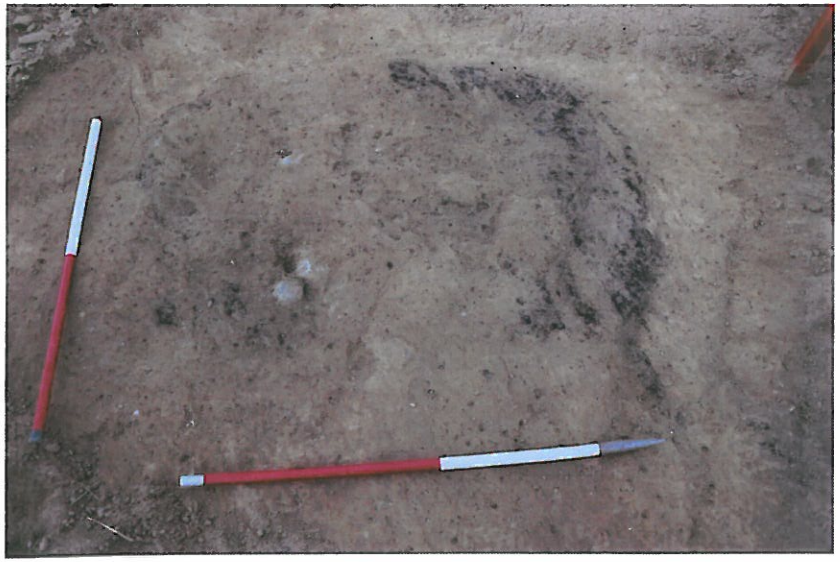

Plate 1: C301 from east (pre-excavation) (03_29:CP117:13A)

Plate 2: C301 southeast facing section (03_29:CP117:20A)

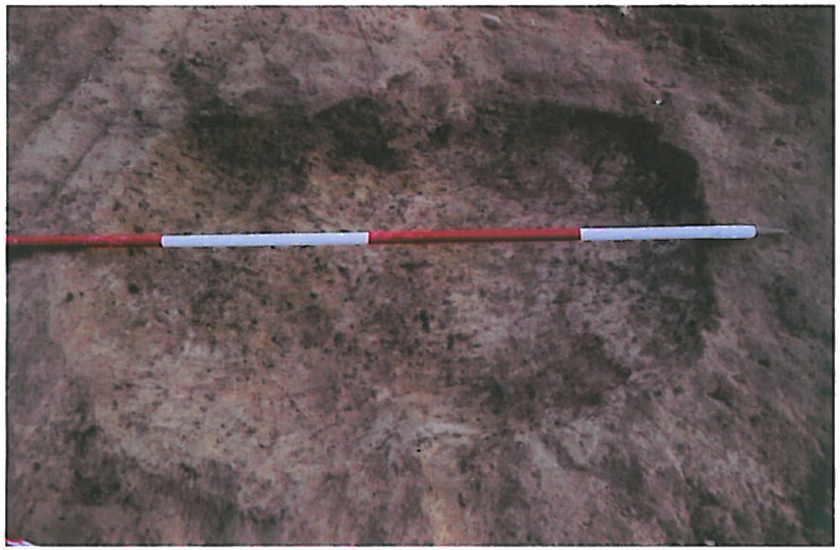

Plate 3: C301 from northwest (post excavation) (03_29:CP117:24A)

Plate 4: C302 from east (pre-excavation) (03_29:CP117:15A)

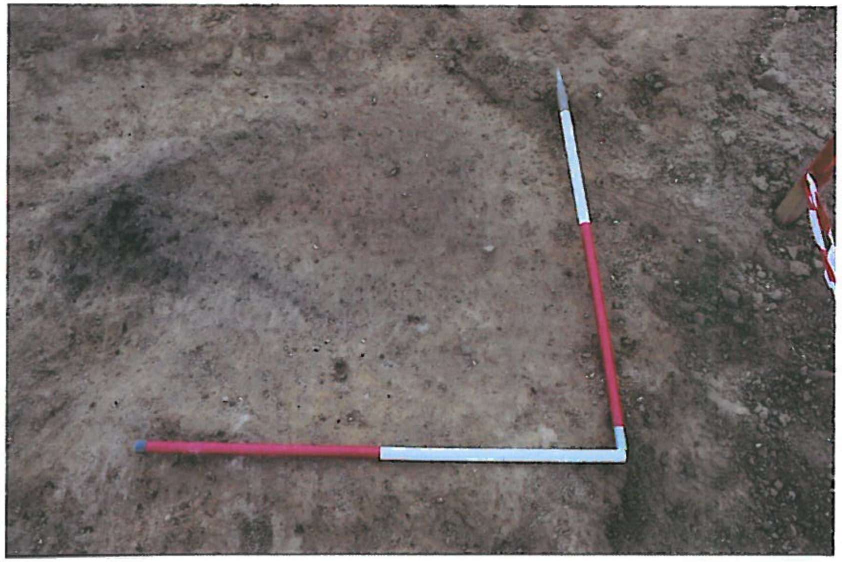

Plate 5: C303 from north (pre-excavation) (03_29:CP117:16A)

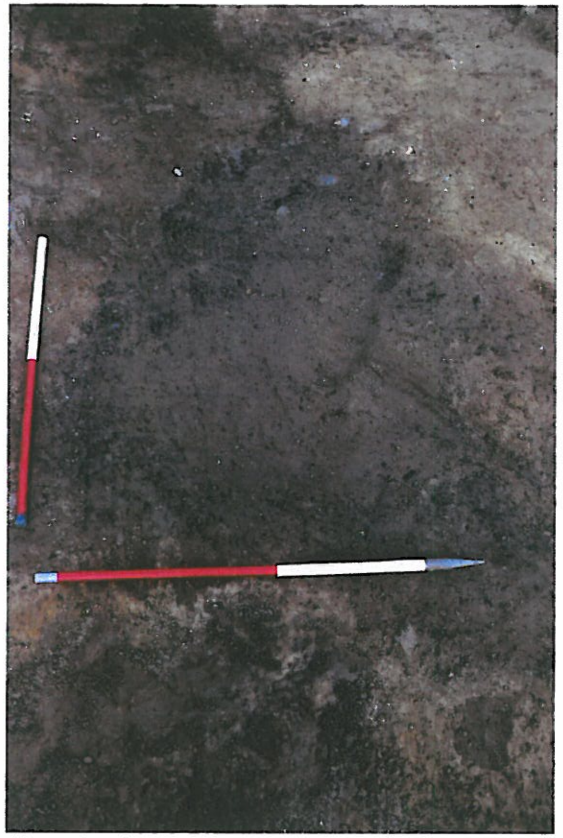

Plate 6: C304 from south (pre-excavation) (03_29:CP117:18A)