Searching for the Roman Highway beside Castleshaw Roman Fort:
Geophysics in Daycroft Field

Figure 1 – Aerial View of Castleshaw Roman Fort with Daycroft Field to left - Credit Joolze Dymond

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Executive Summary

A series of geophysical surveys were carried out on a 270 m long and 30 m wide strip of Daycroft Field to the south of Castleshaw Roman fort in the summer of 2023. The project was instigated by the Friends of Castleshaw Roman Forts with the aim of determining the presence or otherwise of the Roman road termed Road 712 in Daycroft Field (Margary, 1973). The surveys were carried using earth resistance, gradiometer, and ground penetrating radar (GPR) techniques. The earth resistance survey work was carried out by Phil and Sarah Barrett on behalf of the Friends of Castleshaw Roman Forts. The gradiometer and ground penetrating radar surveys were carried out as part of an MA dissertation at the Department of Archaeology of the University of Sheffield (Jeffery, 2023). In addition, a re-examination of Lidar data in and around Daycroft field was carried out to aid interpretation of the geophysical surveys.

The site comprises part of a pastoral field immediately to the south of Castleshaw Roman Fort, known as Daycroft Field located at grid ref 399870 409550. Note that it forms part of the Scheduled Monument for which a Section 42 licence for the geophysical survey was granted on 17th April 2023.

The earth resistance survey was carried out between 20th May and 30th July 2023. The gradiometer survey was carried out between 20th and 22nd May 2023. The GPR survey was carried out between 26th May 2023 and 6th June 2023.

The reinterpretation of the Lidar data provided strong evidence of Road 712 at the western end of Daycroft Field and to the east of Castleshaw hamlet in the form of two parallel carriageways climbing towards the Standedge escarpment.

The earth resistance survey provided good contrast between low and high resistance features. Evidence for Road 712 was most clear at the western end of the survey. The gradiometer survey provided evidence of activity to the south of the fort but with insufficient detail to distinguish individual features. The ground penetrating radar survey provided evidence of a larger number of features and gave approximate information on the depth of the features. This included agricultural features at shallow depths, evidence of buildings to the south of the fort and strong evidence of a deep southern ditch of Road 712 connecting to the south gate of the fort.

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Introduction

Project Background

The Friends of Castleshaw Roman Forts have been undertaking a series of archaeological investigations into the area immediately outside the Roman forts at Castleshaw. See website www.castleshawarchaeology.co.uk for further details.

Recent excavations have been focussed on an area to the east of the forts. This has produced evidence of an annexe (Redhead, 2023), (Redhead, 2024). The road layout has remained unclear, and it was decided to look again at the area to the south of the forts.

The area to the south of the forts was the subject of an earth resistance survey in the 1990s. This was followed in 1994 and 1995 by archaeological excavations in the form of test pitting and trial trenches undertaken by Greater Manchester Archaeological Unit (Redhead, 1996, Redhead, 1997).

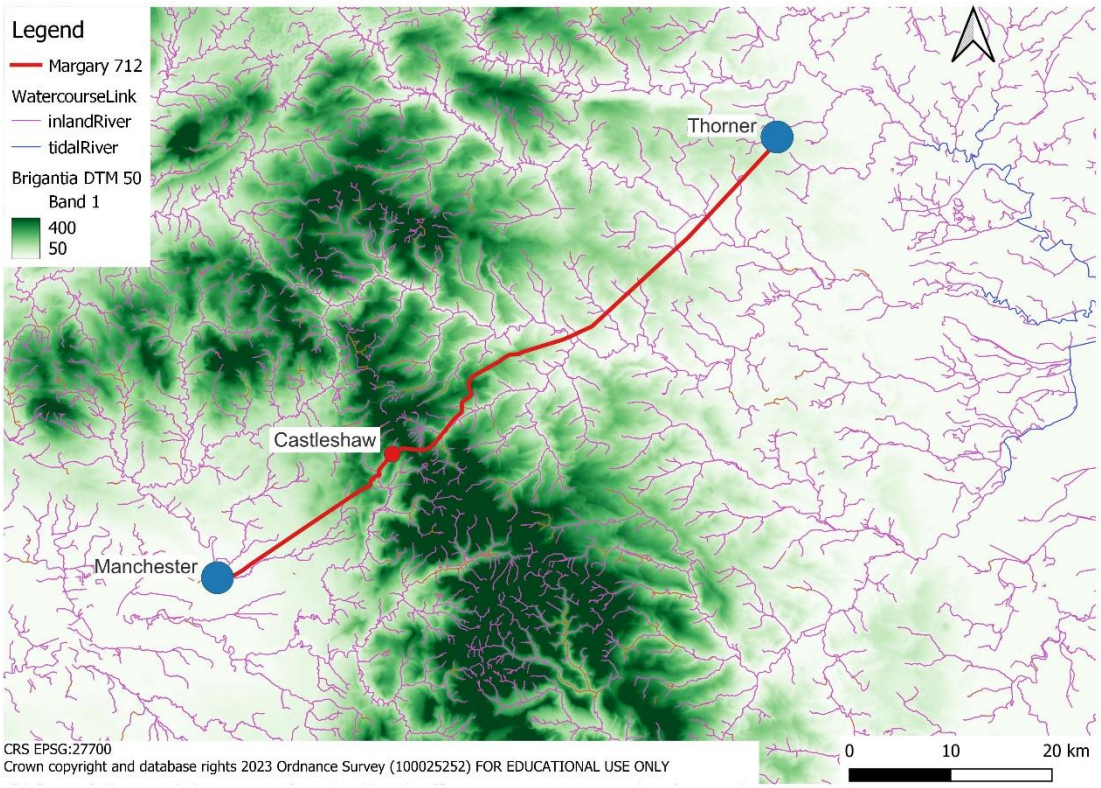

Figure 2 - Location and extent of Road 712

An area of 0.81 ha, 270 m long by 30 m wide, was chosen for geophysical survey as this was felt likely to contain the main cross-Pennine Roman road which was thought to link to earlier

roads at Manchester and Thorner to the northeast of Leeds (Figure 2). Margary in his study of Roman roads in Britain allocated this road the number 712 (Margary, 1973).

The use of ground penetrating radar offered the prospect of revealing the archaeological features at differing depths. This was supplemented by earth resistance and gradiometer surveys.

Site Location and Topography

Castleshaw Roman forts stand on a spur in the Castleshaw Valley above the confluence of Waters Clough and Hull Brook (Figure 3).

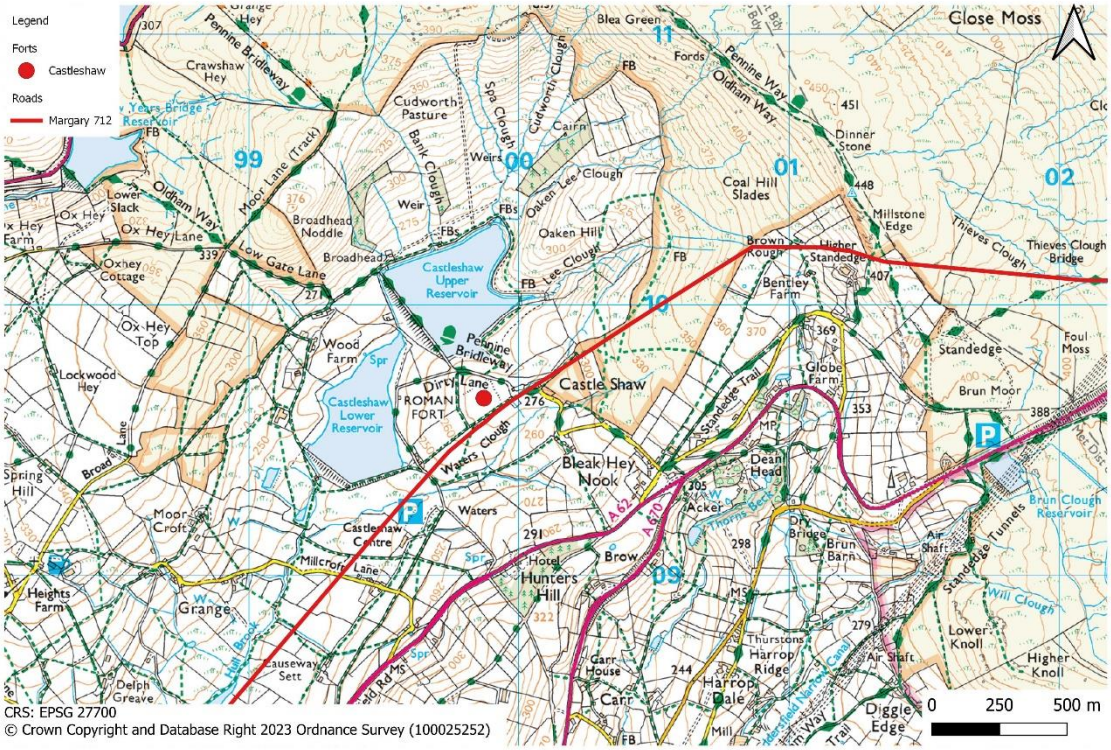

Figure 3 – Castleshaw Roman Forts Location

Road 712 approaches the fort to the east of Hull Brook in the bottom of the valley and then crosses Waters Clough before climbing towards the forts and is shown in grey in Figure 4. Daycroft Field slopes to the south away from the Castleshaw forts (Figure 5). The highest point of the field is 276 m AOD and the lowest 236 m AOD.

Figure 4 - View from drone looking west from above Castleshaw forts - Credit Joolze Dymond - the position of the road deduced from Lidar observations is shown in grey and Daycroft Field is to the south of the fort

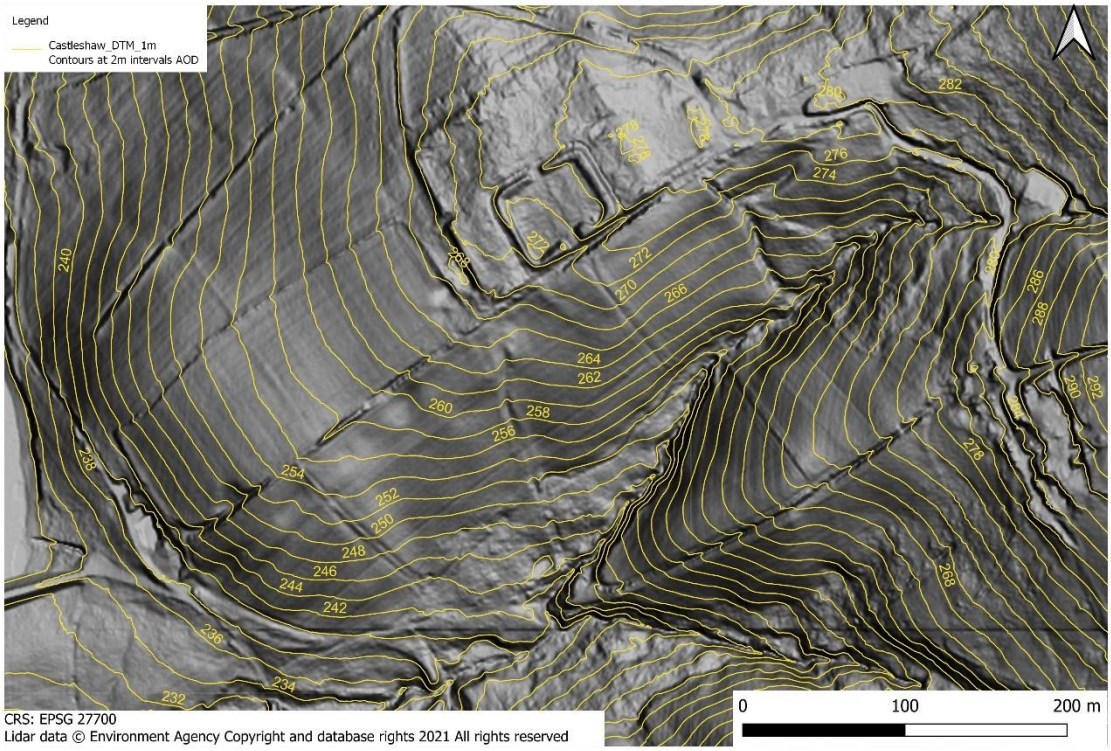

Figure 5 – 2 m contour plot of Daycroft Field from Lidar DTM 1m

Figure 6 - View from drone looking east from above Castleshaw forts - Credit Joolze Dymond - the position of the road deduced from Lidar observations is shown in grey

To the east of the Castleshaw forts the land rises towards the Standedge escarpment (Figure 6). Road 712 climbs the moorland before turning to pass through a cutting at the edge of the escarpment and is shown as grey lines in the figure.

Geology

The Castleshaw Roman forts are located on a spur of Shale Grit sandstone (SG-SDST Figure 7). Above and below the spur the road passes over mudstones and siltstones (HEBD-MDSI Figure 7) of the Hebden Formation. To the east of the forts the road rises to its highest point on the Standedge escarpment of Lower Kinderscout Grit (LK-SDST Figure 7).

The superficial geology shows no superficial deposits at the Castleshaw Roman forts site (Figure 8).

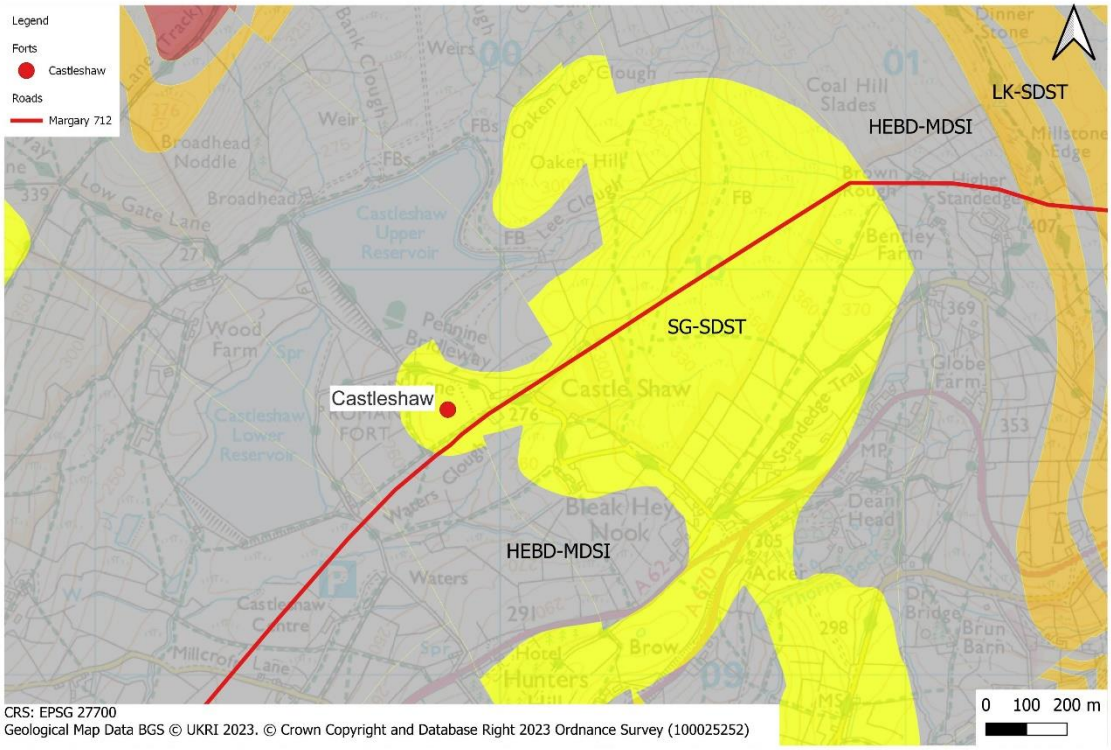

Figure 7 - Castleshaw Geology - Bedrock and Linear

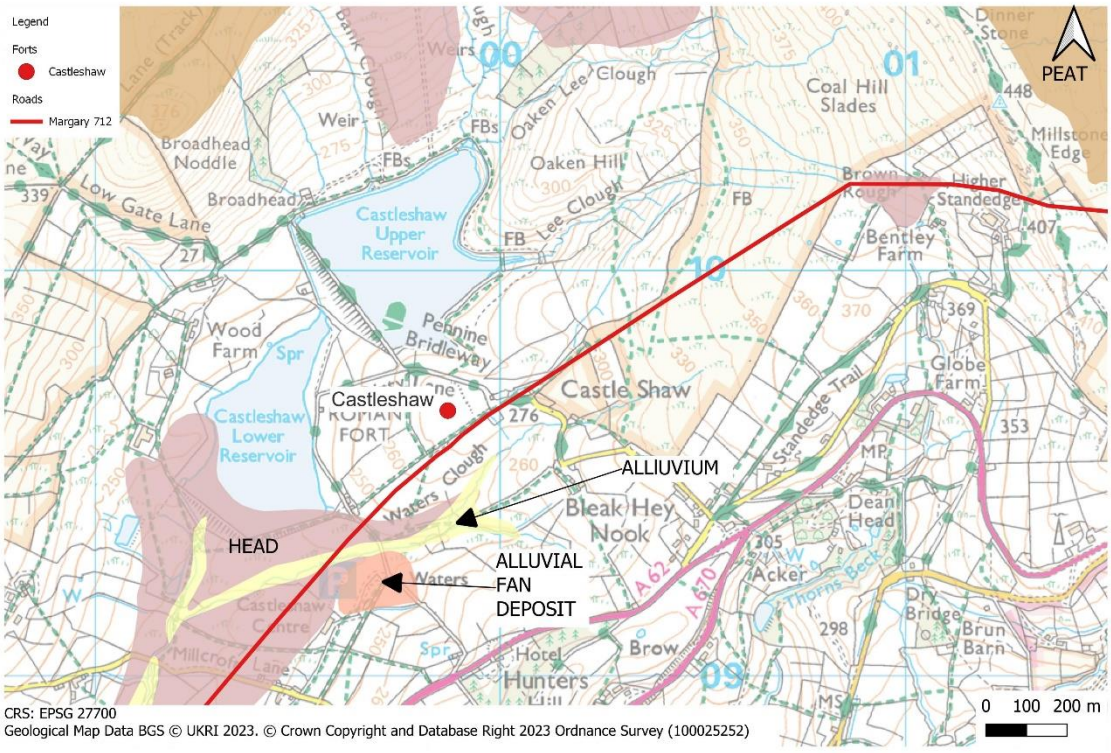

Figure 8 - Castleshaw Geology - Superficial Geology

Archaeological and Historical Background

The Roman character of the road between Manchester and Castleshaw was noted at least by the time of Thomas Percival (Percival and Willoughby, 1751). Percival also recorded the Roman fort at Manchester and recorded two Roman camps at the Castleshaw site (Percival and Willoughby, 1751). The Roman fort at Slack was also recognised by the eighteenth Century (Whitaker, 1771). Percival recognised the significance of the Antonine Itinerary to the road (Percival and Willoughby, 1751). The Antonine Itinerary is a series of documents dating to the second century CE which details routes along the roads of the Roman Empire. It lists starting points and destinations with distances between stopping points along the routes (Rivet and Jackson, 1970).

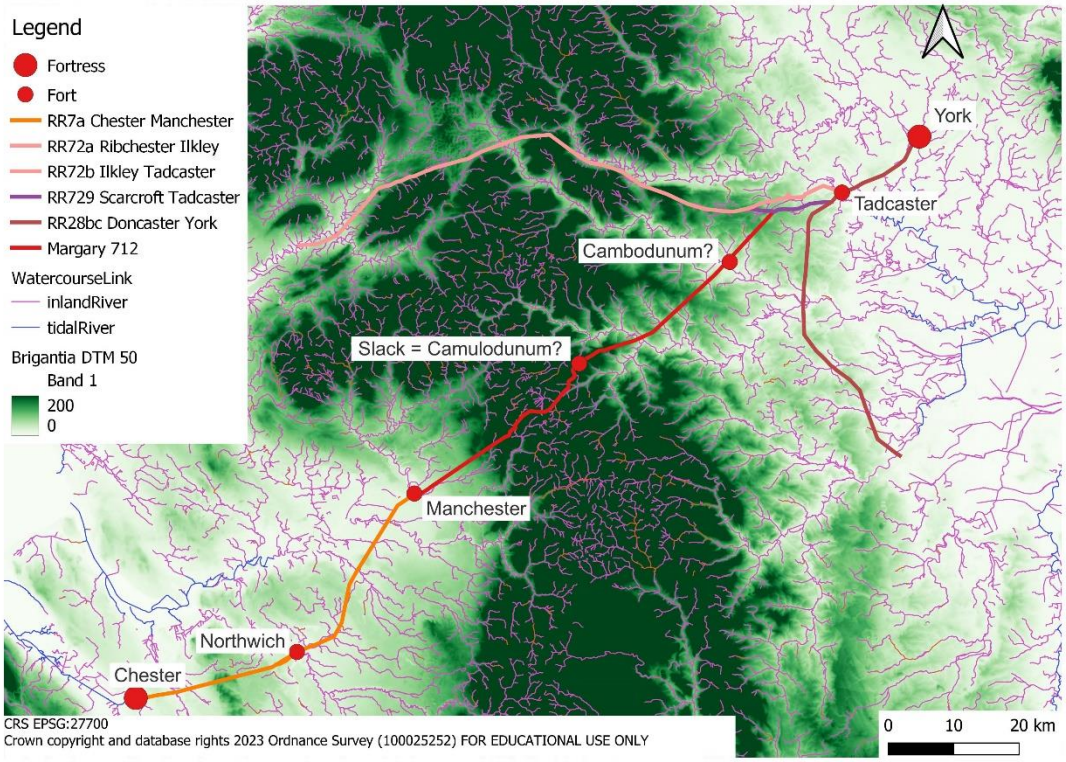

Figure 9 – Iter II stopping places between York and Chester with roads described by Margary

Iter II of the British section of the Itinerary lists stopping places between Birrens in southwest Scotland and Richborough in Kent (Rivet and Jackson, 1970). A section of the route is from York to Chester with intermediate stopping places at Calcaria (probably Tadcaster), Cambodunum (probably Leeds), Mamucium (Manchester) and Condate (probably Northwich) (Figure 9).

Numerous copying errors have been found in the Itineraries. In particular, in Iter II, the mileage between Tadcaster and Manchester is around 15 miles short which would be atypical of the accuracy of the itineraries (Rivet and Jackson, 1970, pp. 157-60). A station at Camulodunum may have been omitted (Rivet and Jackson, 1970, pp. 158-9) and this may relate to the Roman settlement at Slack. Camulodunum was described as being in the area occupied by the Brigantes by Ptolemy and is usually taken to include the Pennines (Rivet and Jackson, 1970, p. 120). This identification has been incorporated into Table 1 although distance errors remain.

Table 1 - Iter II stopping places and distances

Stopping place in Iter II (Rivet and Jackson, 1970)	**Distance from previous location (Roman miles)**	**Identification**	**Actual distance (Roman miles)**	**Distance error (Roman miles)**	**Comment**
Eburacum		York			
Calcaria	viiii	Tadcaster?	9.6	-0.6	Measure to centre of fortress?
Camboduno	xx	Leeds?	14.0	+5.0	Assume mileage was xv and lost
(Camulodunum?)	(xx)	(Slack?)	(19.8)	(0)	Assume mileage xx referred to this leg
Mamucio	xviii	Manchester	23.4	-5.4	Assume xxiii
Condate	xviii	Northwich?	19.6	-1.6	xx confused with below
Deva leg XX Vic	xx	Chester	19.0	-1.0	Measure to centre of fortress?

Two local groups have excavated on the line of the road. To the south west of Castleshaw the Bradford Grammar School Archaeological Society and the Saddleworth WEA Archaeology Class jointly carried out a study which included the excavation of two sections across the road (Haigh, 1982). The sections showed the metalled road surface to be between 6 m and 7 m wide and between 0.5 m and 0.6 m thick. Between Castleshaw and Slack 13 sections have been excavated across the line of the road by the Huddersfield and District Archaeological Society over a period of more than 40 years (Lunn et al., 2008). These excavations revealed a metalled surface between 6 m and 7 m wide with side ditches and presented a major amendment to Margary's suggested route (Figure 10).

The ditches and metalling of a road, interpreted as Road 712 were also found immediately south of Daycroft field in 2011 (Mounsey, 2011). The metalling was denuded so that its original width was not discernible, however shallow ditches 6.5m apart were found (Mounsey, 2011, p. 21).

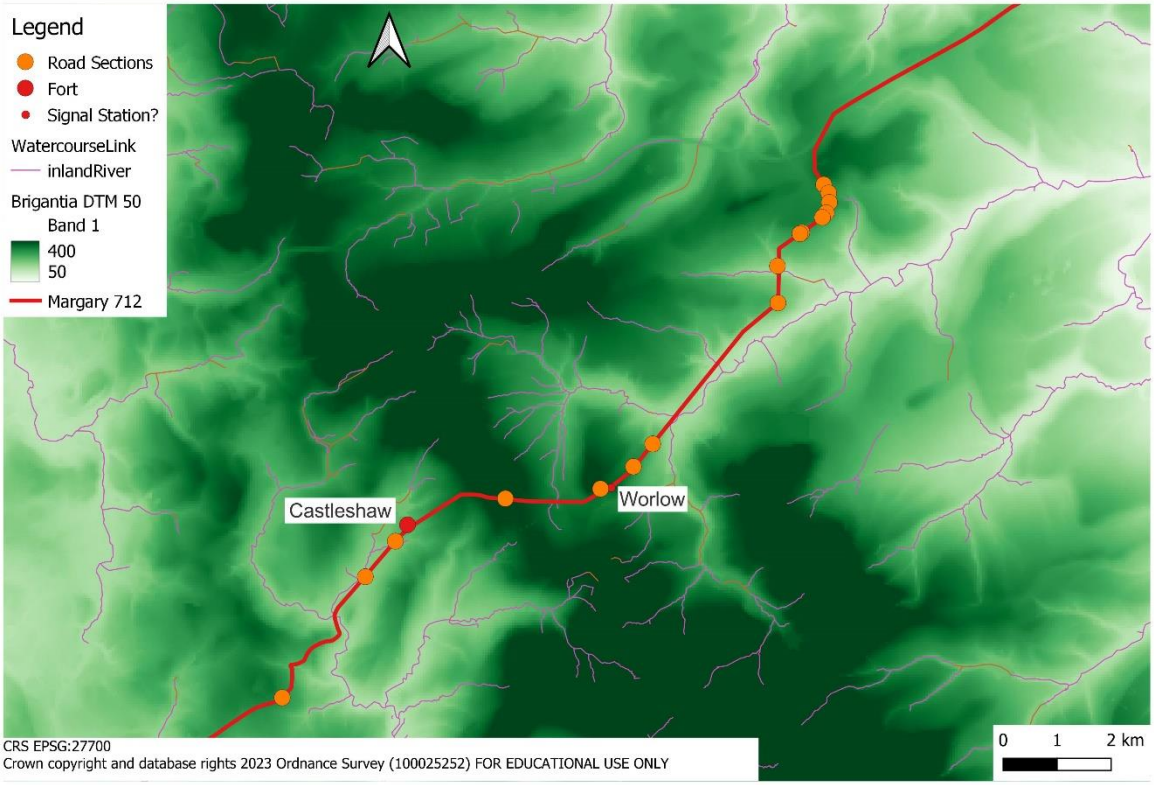

Figure 10 - Excavations on line of Road 712 around Castleshaw

The alignment of the Roman road at Castleshaw Roman forts has remained uncertain despite a series of excavations being undertaken there (Redhead, 1996), (Redhead, 1997). An initial examination of Lidar data was carried out which suggested that the extrapolated alignments of Road 712 pass to the south of the forts. This report is based on original survey work which sought to look for evidence of Road 712 south of the forts and determine its relationship to the forts.

The Roman forts at Castleshaw were excavated in 1897 and 1898, however, the excavations were not recorded (Redhead et al., 1989).The site was again excavated in 1907 and 1908 by Francis Bruton (Redhead et al., 1989). Richmond established the sequence at Castleshaw of a

fortlet built inside an earlier fort (Richmond, 1922). The fortlet at Castleshaw was partially re-excavated between 1984 and 1989 (Redhead et al., 1989).

There is an ongoing programme of community excavations at Castleshaw by the Friends of Castleshaw Roman Forts. There was also a series of excavations undertaken by the Greater Manchester Archaeological Unit and volunteers in 1994-6 to the south and west of the fort (Redhead, 1996) (Redhead, 1997) and a larger community excavation mainly funded by the National Lottery in 2014 which re-investigated the fort (Nash et al., 2016).

The excavations in 1994-6 were intended to determine the alignment of Road 712 and look for evidence of Roman activity on flat ground immediately south of the fort. The excavations had been preceded by a resistivity survey (Redhead, 1996), but this had proved inconclusive. The excavations were firstly carried out in Daycroft Field to the south of the fort and then in a field named The Tangs to the west of the fort and are summarised in Figure 11.

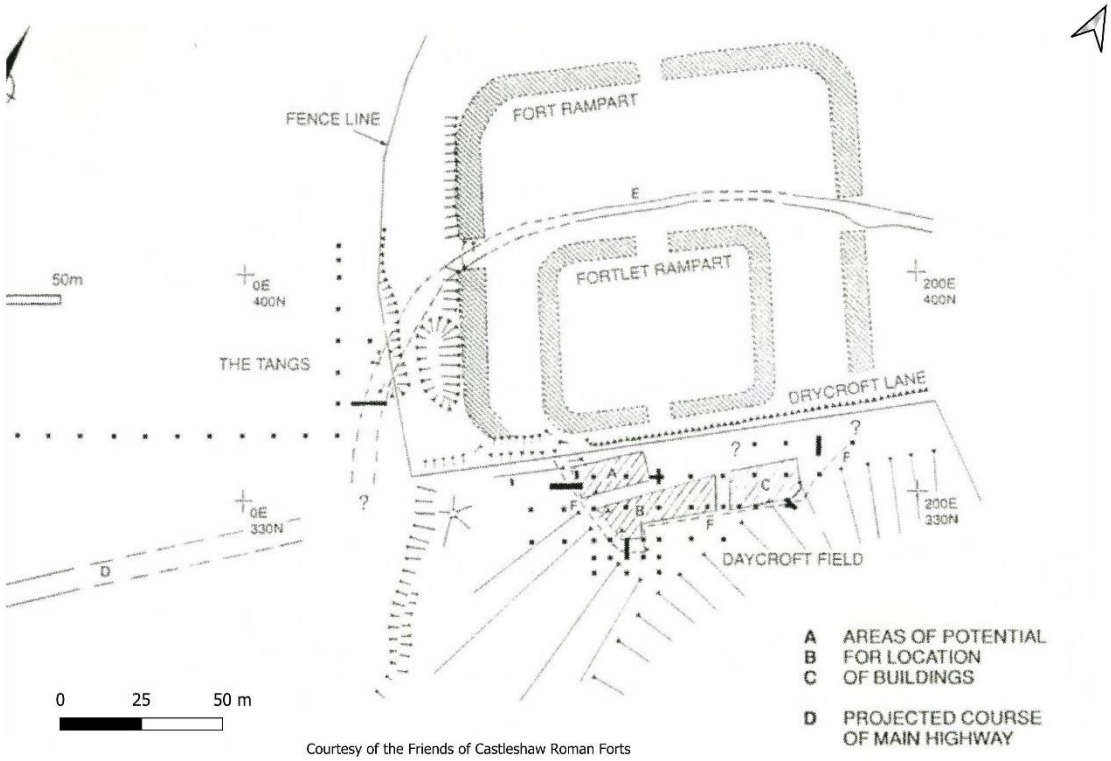

Figure 11 – Investigations by GMAU in the Tangs and Daycroft Field 1994-6

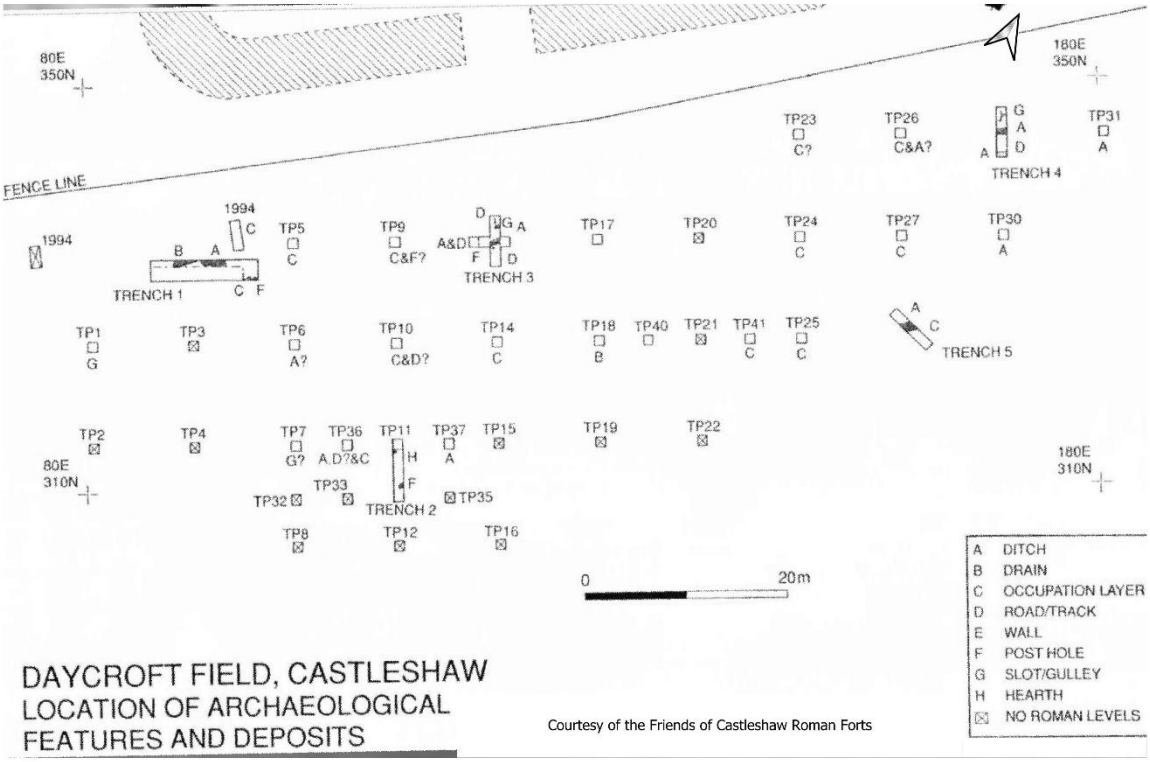

Figure 12 - Investigations by GMAU in Daycroft Field 1994-6

The investigations in Daycroft Field outside the south gates of the fort and fortlet are shown in detail in Figure 12. These excavations comprised a grid of 1 m square test pits, some of which were extended into trenches. The excavations revealed evidence of ditches and post holes, a building foundation wall, a hearth and a possible road and track. From this, three areas of potential buildings were identified together with a narrow track. The excavators concluded that there was a small vicus of fortlet date (i.e. circa 120 CE) overlying an earlier highway alignment associated with the construction of the original fort (Redhead, 1997). The archaeological remains were found at a depth of between 0.6 m and 1.2 m. Overlying the archaeological remains was topsoil and plough soil each of around 0.3 m depth with evidence that a considerable period of ploughing had denuded physical evidence (Redhead, 1997).

Methods (Techniques and Methodologies)

Methodology for Processing of Lidar Data

Processing of the recently available Lidar data was carried out using the QGIS version 3.28.15 multidirectional hillshade algorithm with a 4x vertical exaggeration and an elevation of 45°.

Methodology for setting out Geophysical Survey

The plan of the excavations by the Greater Manchester Archaeological Unit was georeferenced and the most southerly credible alignment of the Road 712 superimposed onto it.

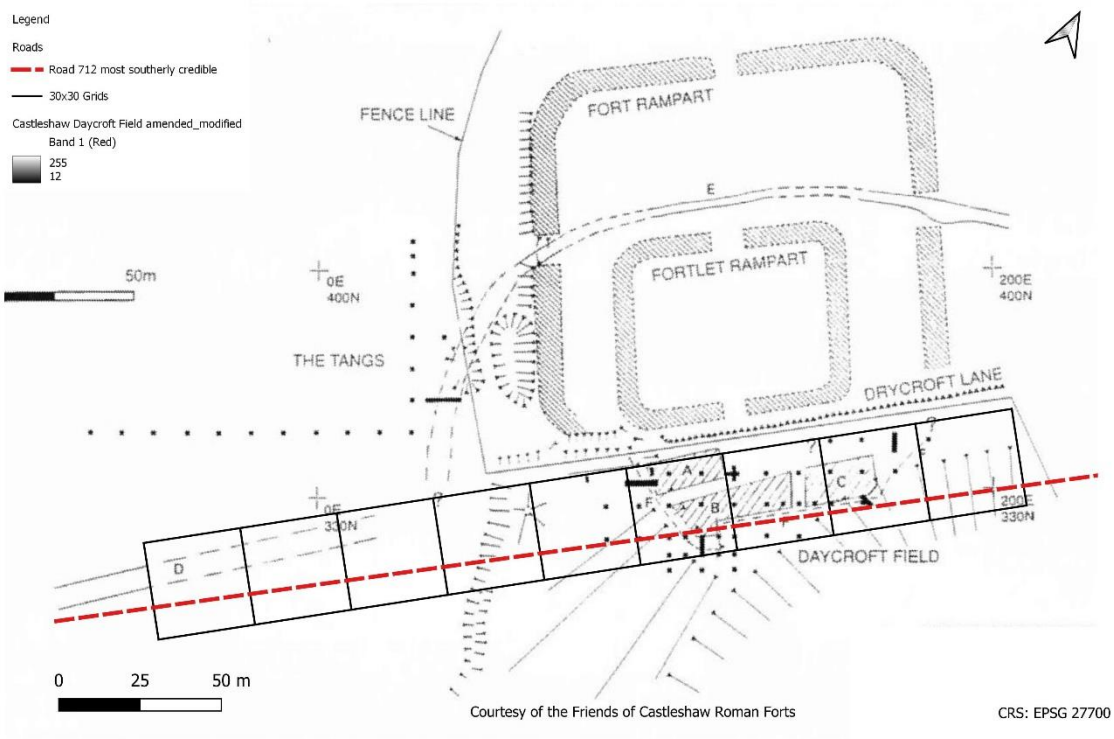

Figure 13 – Geophysical survey area

A survey grid was designed which covered the range of likely alignments of the Road 712 and the junction of the road with a loop road into the fort (Figure 13). The loop road was interpreted as relating to the fortlet phase of circa 120 CE when construction activity south of the fort had obstructed the line of the original road (Redhead, 1997). A licence for a geophysical survey was required from Historic England as the survey area was within a Scheduled Ancient Monument. This was applied for in March 2023 and a licence was granted in April 2023.

The area shown in Figure 13 was surveyed using geophysical techniques that have not been used in the area before as part of a MA study (Jeffery, 2023). This comprised a gradiometer survey (Schmidt et al., 2015) and a Ground Penetrating Radar (GPR) survey (Schmidt et al., 2015). Phil Barrett also undertook a new earth resistance survey of the area on behalf of the Friends of Castleshaw Roman Forts.

To reduce errors on the sloping ground, setting out of the survey grids was carried out (Figure 14) using a Global Navigation Satellite System (GNSS) (Historic England, 2017). The survey setting out points are summarised in Table 2 and Figure 15.

Figure 14 – Preparing to set out the survey grid using GNSS equipment (Credit Jayne Redhead)

Table 2 - Setting Out Points to BNG

Setting Out Point	*Easting*	*Northing*
N1	*399968.581*	*409646.383*
S1	*399986.118*	*409622.043*
N2	*399944.240*	*409628.847*
S2	*399961.777*	*409604.506*
N3	*399919.900*	*409611.310*
S3	*399937.436*	*409586.969*
N4	*399895.559*	*409593.773*
S4	*399913.096*	*409569.433*
N5	*399871.218*	*409576.237*
S5	*399888.755*	*409551.896*
N6	*399846.878*	*409558.700*
S6	*399864.414*	*409534.359*
N7	*399822.537*	*409541.163*
S7	*399840.074*	*409516.823*
N8	*399798.197*	*409523.627*
S8	*399815.733*	*409499.286*
N9	*399773.856*	*409506.090*
S9	*399791.393*	*409481.749*
N10	*399749.515*	*409488.553*
S10	*399767.052*	*409464.213*

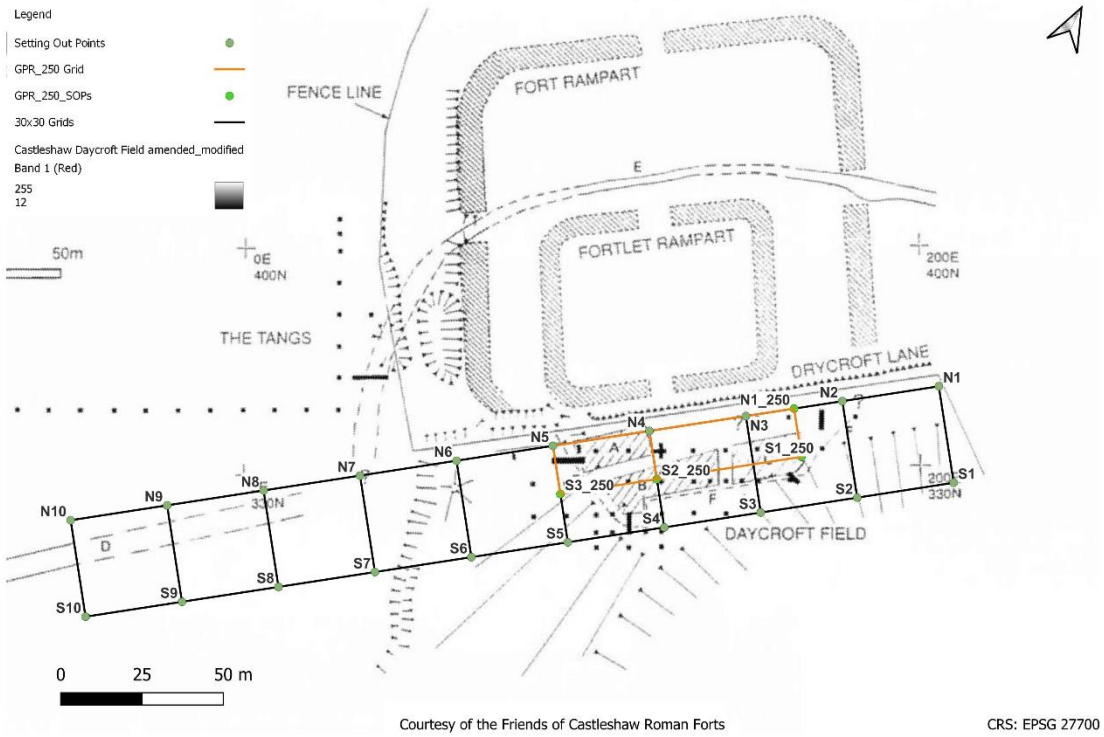

Figure 15 - Survey setting out points and grids

For the grid points for a second GPR survey area which provided closer detail outside the forts, additional points were set out using tapes from the midpoints between N2 and N3 (= N1 250), S2 and S3. A point was then established by tapes offsetting 15 m from N1 250 and the midpoint between S2 and S3 (=S1 250). N2 250 was identical to N4 and N3 250 was identical to N5. Points were established by offsetting 15m from N4 towards S4 (= S2 250) and 15m from N5 towards S5 (=S3 250). The method of taping from the baseline between N points was adopted to minimise slope errors caused by the steeply sloping ground in the southern part of the 30m grids.

Methodology for Earth Resistance Survey

On 20th and 21st May 2023, the Friends of Castleshaw Roman Forts collected resistivity data in the five easternmost grids. The equipment used was a Frobisher TAR-3 Resistance meter (owned by the Friends of Castleshaw Roman Forts) with mobile twin probes at 0.5 m spacing (Figure 16), and remote twin probes kept 15 m to 20 m away from the average grid position of the mobile probes. The survey in each 30 m x 30 m grid progressed southwards with alternate east-west/west-east traverses starting in the northeast corner (Figure 17). The final

four grids were surveyed on 28th and 29th July. At the time of the survey, the field was relatively short grass and mainly used for sheep grazing.

Figure 16 – Earth resistance survey equipment

Figure 17 – Survey commencement at point N1

Methodology For Gradiometer Survey

The possible presence of buildings and hearths outside the fort could have produced areas of burning which are particularly suitable for detection by magnetometry (Historic England, 2017).

In this survey the type of magnetometer used was a gradiometer. The survey was carried out using a Bartington 601 gradiometer with twin sensors at 1 m separation and a DL601 data logger (Figure 18). The reading interval was 0.25 m and data were collected in bi-directional traverses at 2 m intervals to give an effective traverse interval of 1 m. The survey lines were carried out perpendicular to the assumed line of the road. The data were collected on 20th May 2023 and 22nd May 2023. The data were collected starting from the westernmost grid working eastwards to avoid working in the same area as the Friends of Castleshaw Roman Forts.

Figure 18 - Gradiometer survey being carried out (Credit Zhaxi Luobu)

The weather was dry throughout. Manure had been spread on the ground on 18th May following cutting of a hay crop. Obvious metallic elements in the manure were removed by

hand from the survey area. The same calibration point for the sensors was used on both days at a magnetically quiet point to the south of the survey area.

The data were downloaded directly onto a laptop from the data logger into Snuffler version 1.32 software using the import file facility in Snuffler. As a backup the data were downloaded from the data logger into data files using the Grad601 Communication Application version 3.16 in all 3 available formats, CSV, XYZ and Zgrid. The data were also processed using Geoplot software version 4.00.

Methodology for Ground Penetrating Radar Survey

The GPR survey was carried out using a Crossover 1760 pushcart manufactured by Impulse Radar (Figure 19).

Figure 19 - Collecting GPR data on 500mm grid

The original plan was to survey the whole area of 30 m by 270 m perpendicular to the line of the road with traverses at 0.5 m separation. The gradient in the shorter dimension meant that this would have been extremely difficult, so an alternative strategy was used. This was done

by splitting the 270 m length into three 90 m lengths and surveying parallel to the 90 m lengths. The data were collected in a bi-directional pattern.

To supplement the longitudinal data, an area 75 m wide by 15 m to the south of the fortlet was surveyed perpendicular to the assumed line of the road with traverses at 0.25 m. This area was relatively flat and easier to survey. It was also the area where test pitting had indicated that there were likely to be Roman features.

The data were collected using a GNSS base station and a GNSS rover attached to the pushcart. As the survey progressed the internet connection to the rover became unstable and this method was abandoned. A manual recording system was used as a back-up based on the surveyed grid and tapes run from the grid points. The data were collected in pairs of profiles at 170 MHz and 600 MHz with a reading interval of 0.04 m. The data were collected on 26th, 27th, 28th and 29th May during a prolonged period of dry weather. Due to some blank profiles being found, a further visit was made on Friday 9th June, again during the dry period, to collect the missing data. A minimum of 4 contiguous profiles were collected for each missing profile.

Data were processed using Geolitix software using Cloud based facility. The main 500 mm data and 250 mm data files (>200 MB) were processed using the University of Sheffield's licence. Data files <200 MB were processed using a student licence for cross checking smaller areas of particular interest.

Profiles were processed by first estimating a dielectric constant of the ground of 2.7 (velocity = 0.182 m/ns) for the ground conditions. A preliminary inspection showed that archaeological features were present in the 600 MHz data. The 170 MHz data were not processed further.

A trench of known depth from the 1996 excavations was recognised in the preliminary analysis and was used to give a calibrated dielectric constant for the ground of 4.9 (velocity = 0.136 m/ns) and the analyses were repeated.

Results

Lidar Reinterpretation Results

The reinterpretation of the Lidar data was carried out for the environs of Castleshaw forts (Figure 20). This was based on the Digital Elevation Model (DEM) derived from the Lidar data. The area was selected to include evidence of Road 712.

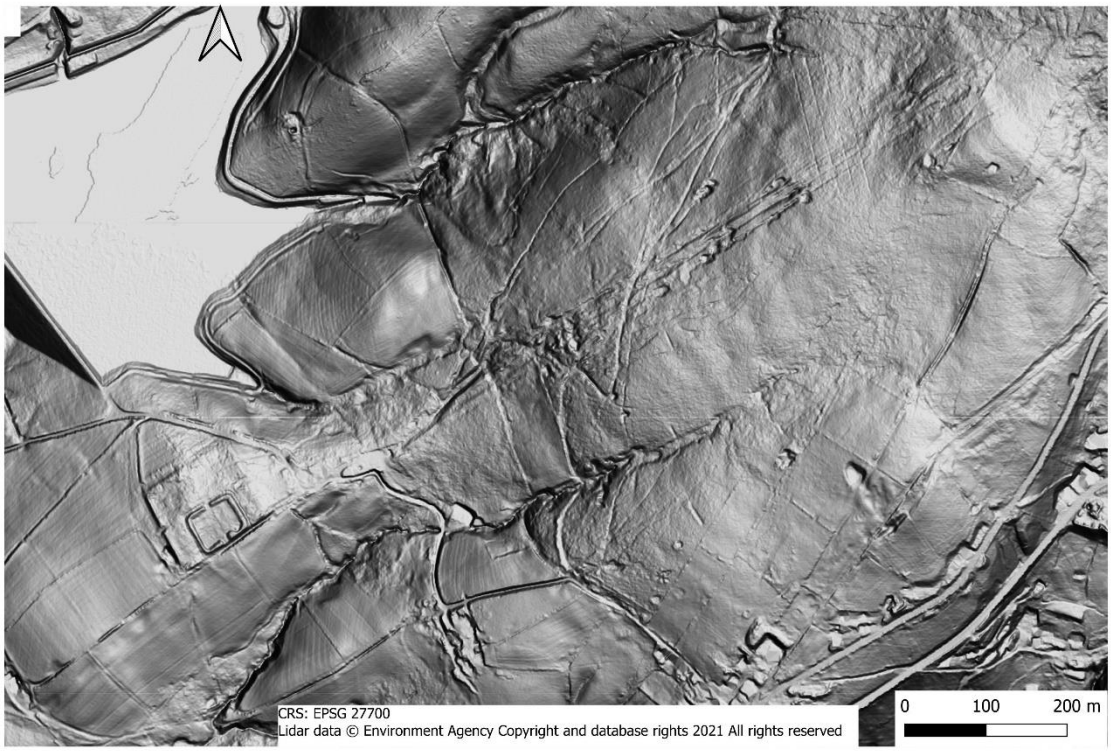

Figure 20 – Castleshaw Forts environs Lidar DTM 1 m Hillshade Alt 45 Multidirectional Z=4

Figure 21 and Table 3 show the interpretation of transportation features.

Features **2001** and **2002** are interpreted as parallel carriageways of Road 712 as the road climbs up towards the Standedge escarpment. Feature **2000** to the southwest of the fort is aligned on Road 712 passing through the Castleshaw valley and is interpreted as part of this road.

Feature **2003** is interpreted as a track of unknown date running down to the deeply incised valley of Waters Clough which the track crosses by means of a zigzag alignment and stone culvert (Figure 21). Feature **2004** appears as a raised spine with flanking ditches and corresponds with a field boundary shown on the 1822 Saddleworth Township map (Buckley

et al., 2010, p. 181) and may be associated with Drycroft Lane, feature **2012**. Features **2006** and **2007** appear to be part of a present-day footpath and features **2008** to **2012** appear to relate to the construction of the Castleshaw Lower reservoir. Feature **2013** appears to be a track leading to a well visible on the 1st Edition 1:10560 Ordnance Survey map of 1854 (Buckley et al., 2007, p. 41).

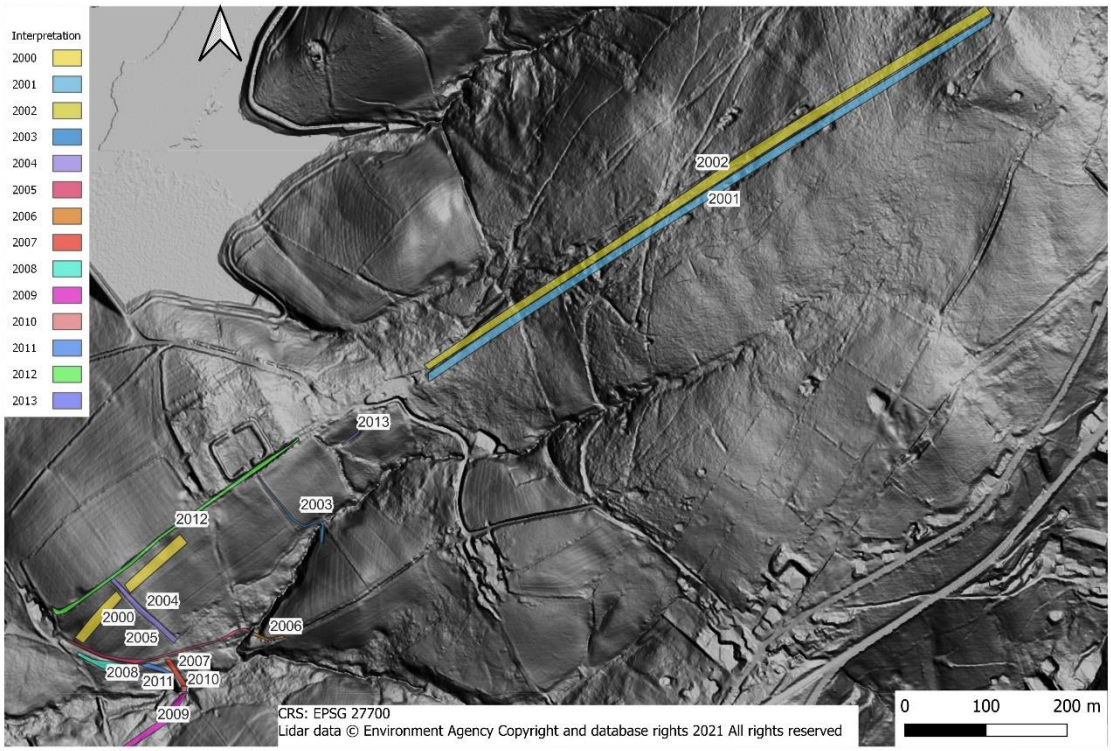

Figure 21 - Castleshaw Forts environs - Lidar interpretation – transportation features

Table 3 - Castleshaw Forts environs - Lidar interpretation – transportation features

Feature number	Archaeological interpretation	Certainty of interpretation	Comment
2000	Road carriageway	Likely	Margary 712
2001	Road east carriageway	Likely	Margary 712
2002	Road west carriageway	Likely	Margary 712
2003	Track	Likely	Includes culverted crossing of Waters Clough
2004	Field boundary	Likely	Field boundary
2005	Road	Likely	Footpath to Higher Castleshaw
2006	Road	Likely	Footpath to Higher Castleshaw
2007	Road	Likely	Disused road
2008	Railway	Likely	Temporary railway for reservoir construction
2009	Railway	Likely	As **2008**

2010	Site of railway bridge	Likely	As **2008**
2011	Railway	Likely	As **2008**
2012	Road and reservoir	Likely	Drycroft Lane
2013	Track	Likely	Track to well

The DEM was then examined for evidence of other features in Daycroft Field (Figure 22).

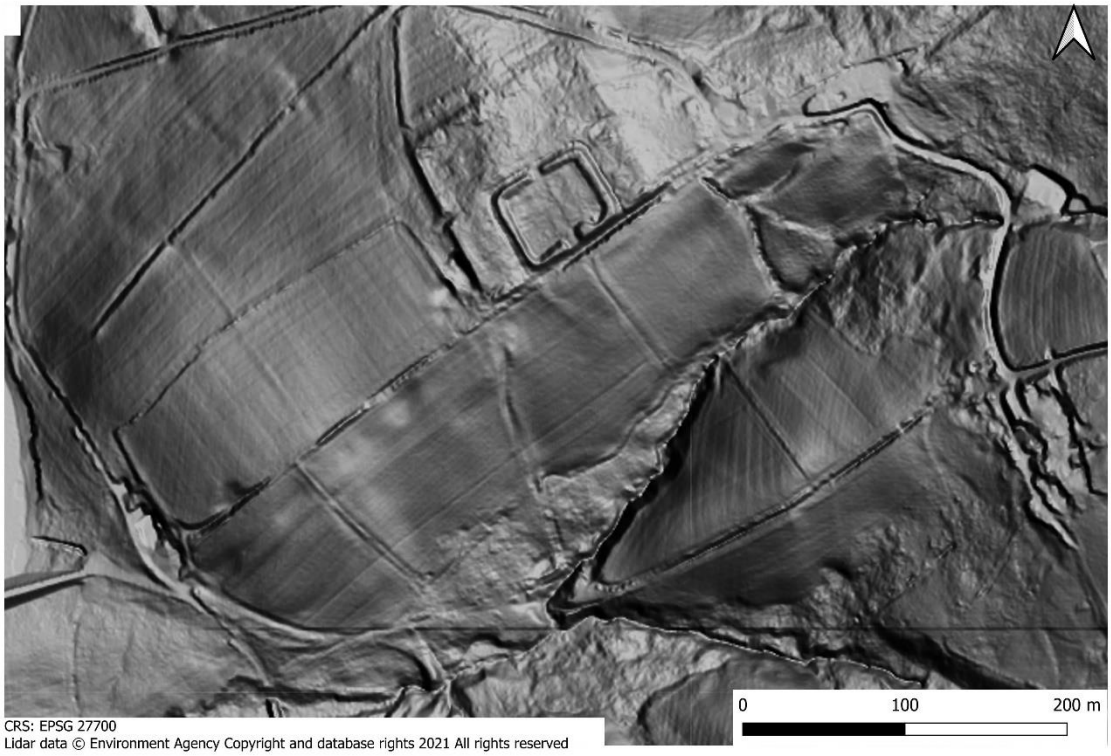

Figure 22 - Daycroft Field environs Lidar DTM 1 m Hillshade Alt 45 Multidirectional Z=4

In addition to the features associated with transportation, agriculture and water management features were interpreted (Figure 23, Table 4). Features **2101**, **2103**, **2113** and **2114** were interpreted as drainage channels running from Drycroft Lane down to Waters Clough. It is notable that features **2101** and **2113** also follow field boundaries shown on the 1822 Saddleworth Township map ((Buckley et al., 2010, p. 181).

Feature **2103** corresponds to a field boundary shown on the 1822 Saddleworth Township map (Buckley et al., 2010, p. 181). Features **2100**, **2104** and **2105** appear to be lynchets associated with ploughing. Features **2107**, **2108** and **2109** appear to relate to quarrying.

Features **2102**, **2111** and **2112** appear to be drainage channels in the Waters Clough valley bottom associated with a pond recorded on the 1st Edition 1:2500 Ordnance Survey map (Buckley et al., 2007, p. 113).

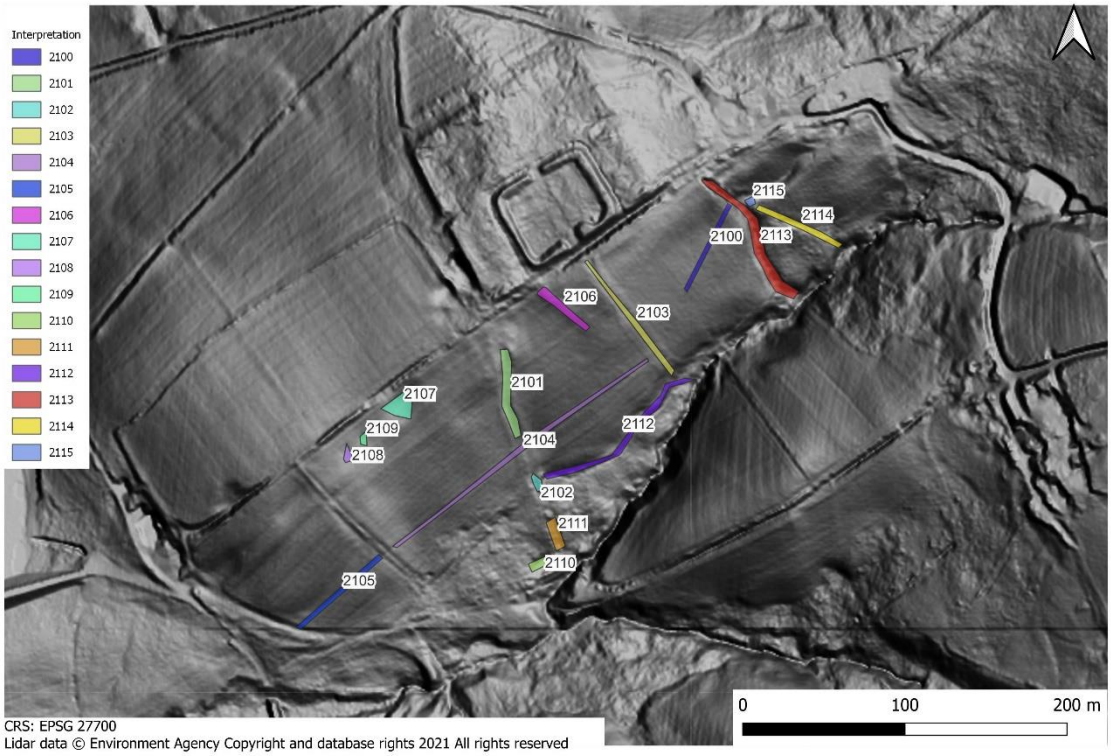

Figure 23 - Daycroft Field environs - Lidar interpretation – water management and agriculture

Table 4 - Daycroft Field environs - Lidar interpretation – water management and agriculture

Feature number	Archaeological interpretation	Certainty of interpretation	Comment
2100	Lynchet	Likely	
2101	Drainage channel	Likely	
2102	Drainage channel	Likely	
2103	Field boundary	Likely	
2104	Lynchet	Likely	
2105	Lynchet	Likely	
2106	Bank	Certain	Excavated in 1995 – interpreted as upcast from ditch
2107	Quarry	Likely	
2108	Quarry	Likely	
2109	Quarry	Likely	
2110	Pond	Likely	
2111	Drainage channel	Likely	
2112	Goyt	Likely	
2113	Drainage channel	Likely	

2114	Drainage channel	Likely	
2115	Well	Likely	

Earth Resistance Survey Results

Each survey square produced 900 data points, a total of 8100 for the 9 squares. The data were processed using the 'Snuffler' Software package. See website www.sussexarch.org.uk/geophys/snuffler.html for further details.

The resulting plot is shown in Figure 24 below (high resistance is darker) and is superimposed onto a plan of the fort (Figure 25).

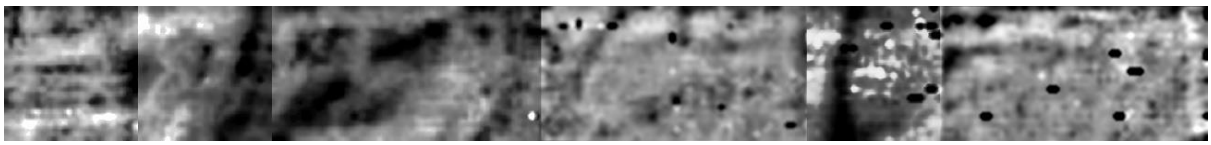

Figure 24 – Earth resistance survey data processed using Snuffler

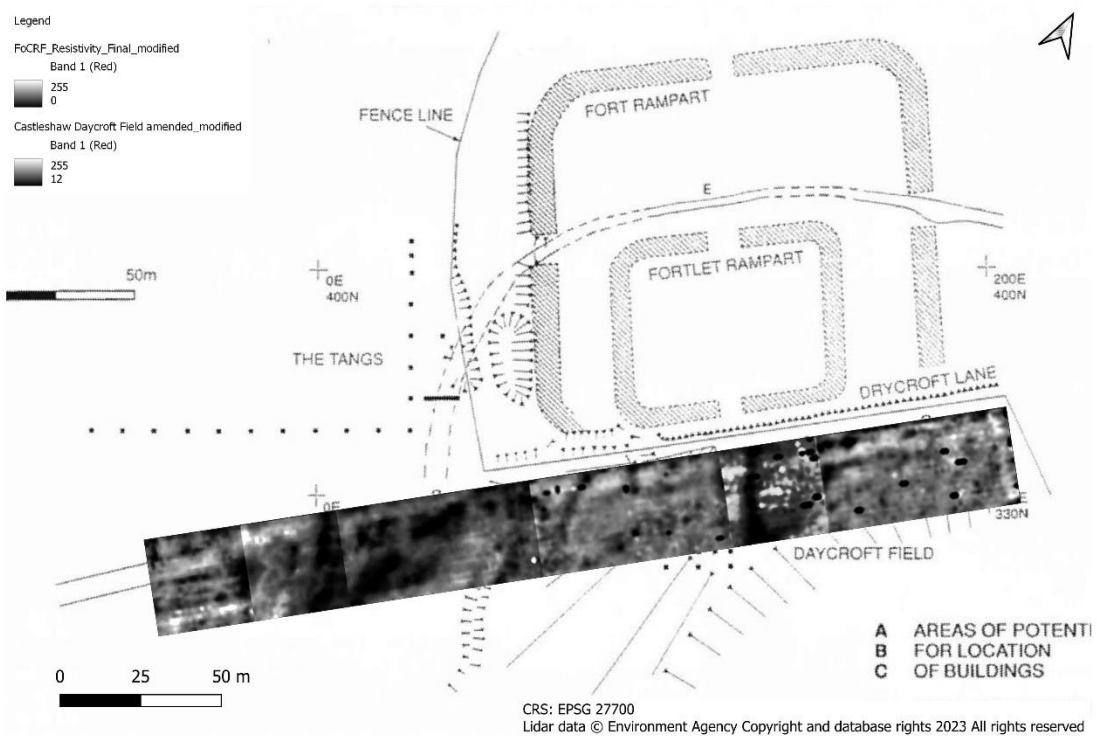

Figure 25 – Earth resistance survey data superimposed onto plan of fort

The interpretation is summarised in Figure 26 and Table 5 and illustrates some of the more obvious linear features and potential area of interest (maybe buildings in the vicus area e.g. features **3003**, **3007**, **3010**).

The dark band leading from the fort's (and fortlet's) south gate (feature **3006**) looks like a road feature but is more likely a (post-) medieval field boundary or infilled drainage channel. Feature **3005** may also be an infilled drainage channel or Roman period ditch, but it is noteworthy that this is parallel to lynchet **2100**.

The linear features **3002** and **3008**, leading from the lower corner of the fort south westerly are slightly sunken damp areas and are possibly to do with drainage (either from the fort, or from Dry Croft lane (The deep ditch running down the southern edge of the fort, which is known to have been used as a medieval/post medieval reservoir). Feature **3002** could be a drain or sunken track leading to feature **3003**. Feature **3009** could also be an infilled ditch on the edge of the field boundary but could also be upcast from the digging out or cleaning of the adjacent ditch.

The linear low resistance features **3001** and **3004** along the top edge of the survey area are likely to be associated with a road and only coincide with the GPR evidence of the Roman road east of the fort's south gate. They are interpreted as a later road of unknown date.

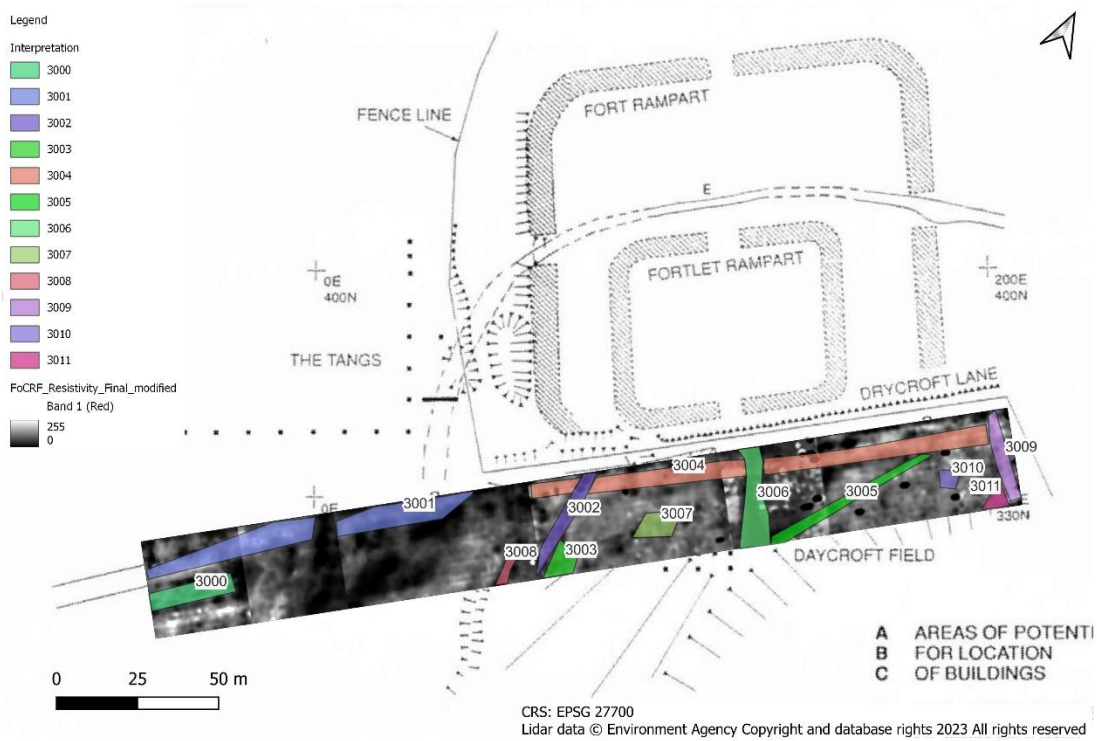

Figure 26 - Interpretation of earth resistance survey data

Table 5 – Earth resistance data processed using Snuffler software - Interpretation

Feature number	Archaeological interpretation	Resistance	Certainty of interpretation	Comment
3000	Road carriageway	High	Probable	Road 712
3001	Track	Low	Possible	
3002	Track	High	Possible	
3003	Building	High	Possible	
3004	Road carriageway	Low	Possible	Road 712 east of **3006**
3005	Infilled drainage channel	High	Possible	
3006	Infilled drainage channel	High	Possible	
3007	Building	High	Possible	
3008	Drainage channel bank	High	Probable	
3009	Ditch	Low	Probable	
3010	Building	High	Probable	
3011	Uncertain	Low	Unknown	

Gradiometer Survey Results

The gradiometer survey on 20th May 2023 produced data that were stripy when viewed with Snuffler software version 1.32 in their unprocessed state. The data for 22nd May 2023 were less stripy. As no record had been taken of the sensor configuration, the data were processed in the Snuffler software in blocks representing each day of collection (Figure 27, Figure 28). For details of the processing of the data using the Snuffler software see Appendix.

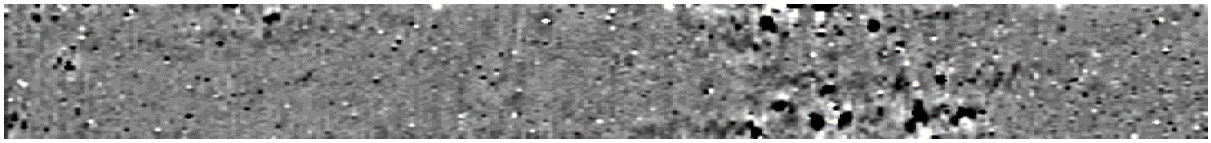

Figure 27 - Gradiometer survey data processed using Snuffler

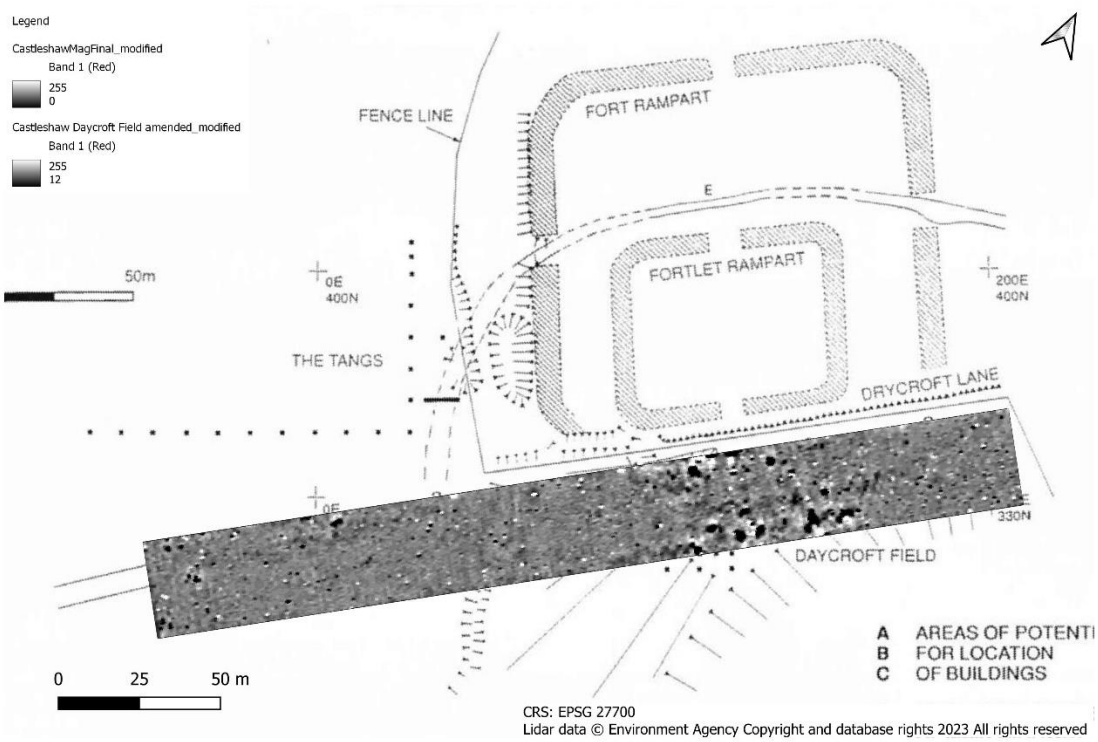

Figure 28 – Gradiometer survey data superimposed onto plan of fort

The data revealed three linear features to the southwest of the fort (Figure 29) and Table 6. Feature **4000** curves and may relate to the northern ditch or kerb of the loop road which heads to the west gate of the fort. Similarly feature **4002** may relate to the southern ditch or kerb of the loop road. Feature **4001** may relate to the eastern wall of the drainage channel which continues as feature **2101**.

The data showed a concentration of magnetic anomalies to the south of the fort features **4003**, **4004**, **4005** and **4006**. It was not possible to discern individual features within these anomalies.

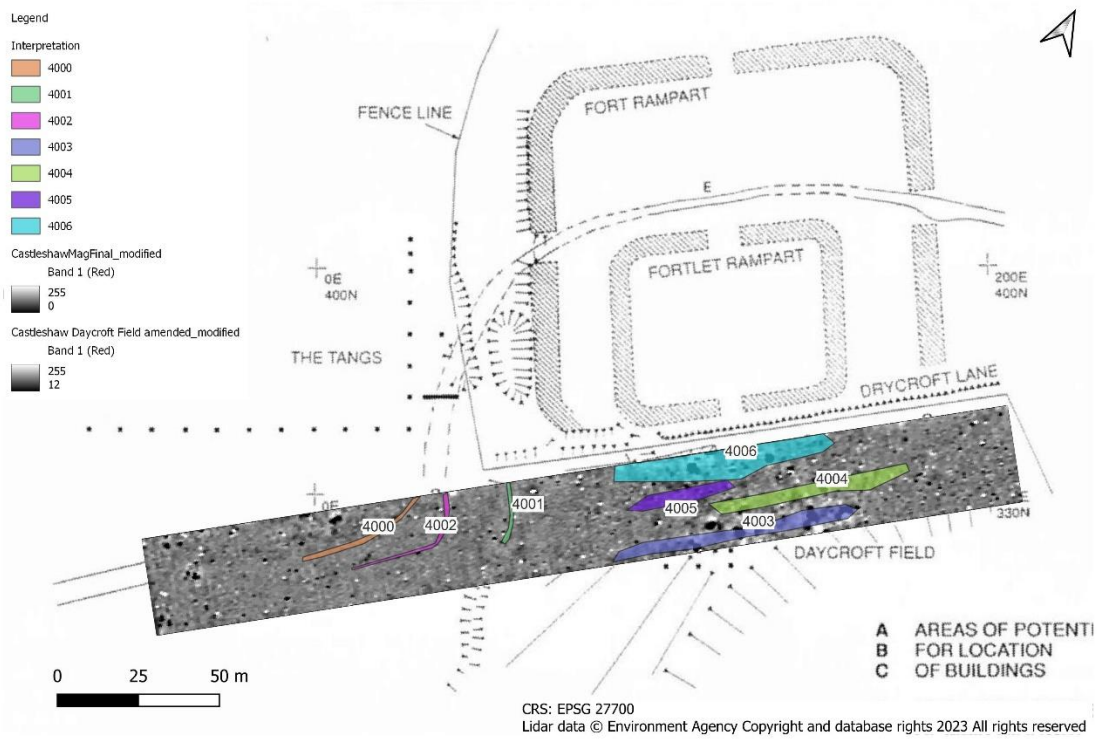

Figure 29 – Interpretation of gradiometer survey data

Table 6 - Gradiometer data processed using Snuffler software - Interpretation

Feature number	Archaeological interpretation	Certainty of interpretation	Type of anomaly	Comment
4000	Road ditch	Probable	Weak positive linear	
4001	Drainage channel wall	Probable	Weak negative linear	
4002	Road kerb	Probable	Weak negative linear	
4003	Occupation	Probable	Positive and negative	Trend
4004	Occupation	Probable	Positive and negative	Trend
4005	Occupation	Probable	Positive and negative	Trend
4006	Occupation	Probable	Positive and negative	Trend

Ground Penetrating Radar Survey Results

The GPR data were processed into a series of slices. The data collected from the three 90 m long traverses with nominal traverse spacings of 500 mm were processed first as this covered

the greatest area. The 600 MHz data was found to be the most informative and was selected for processing (Figure 30, Figure 31, Figure 32, Figure 33, Figure 34).

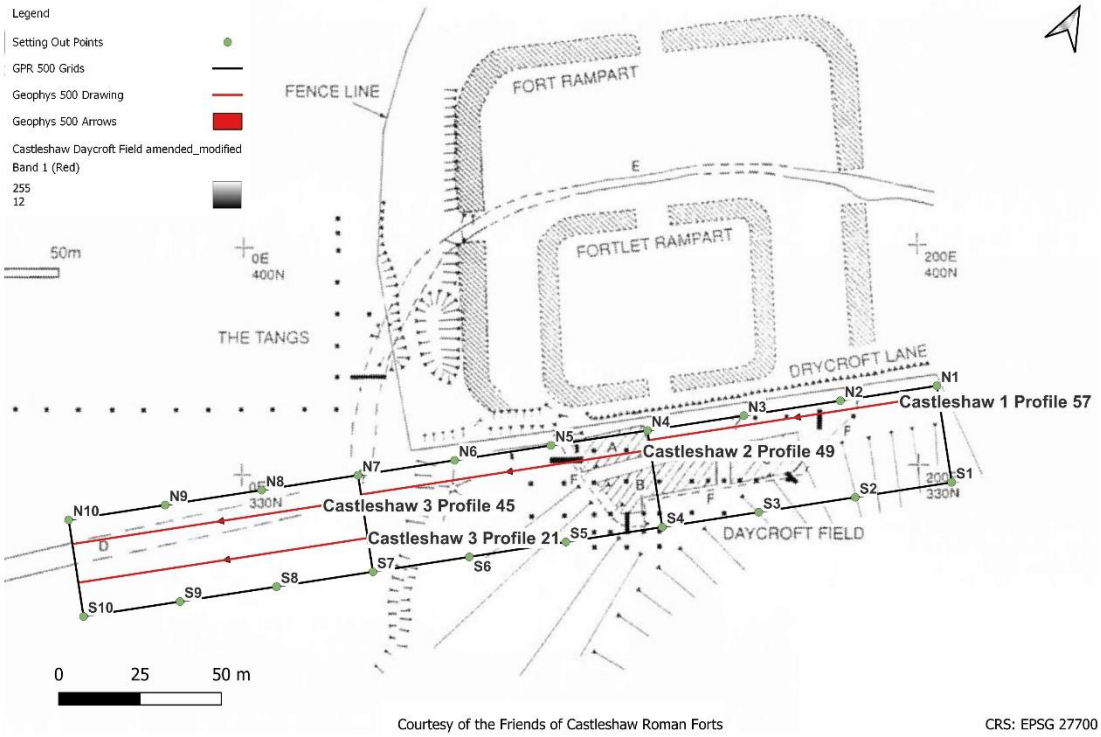

Figure 30 - Selected GPR survey profiles at 500 mm spacing

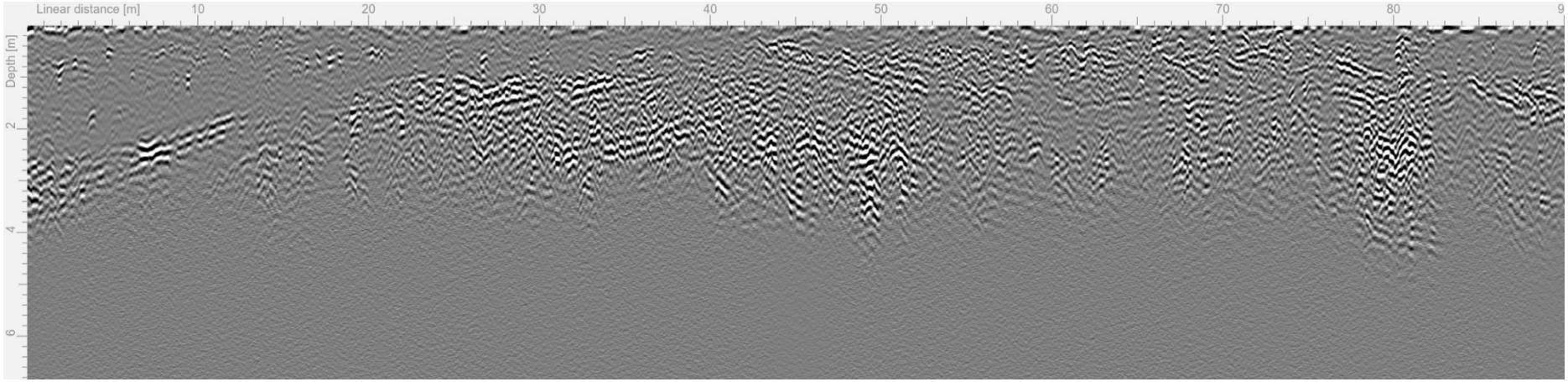

Figure 31 - Castleshaw 1 profile line 57 at X=27 m

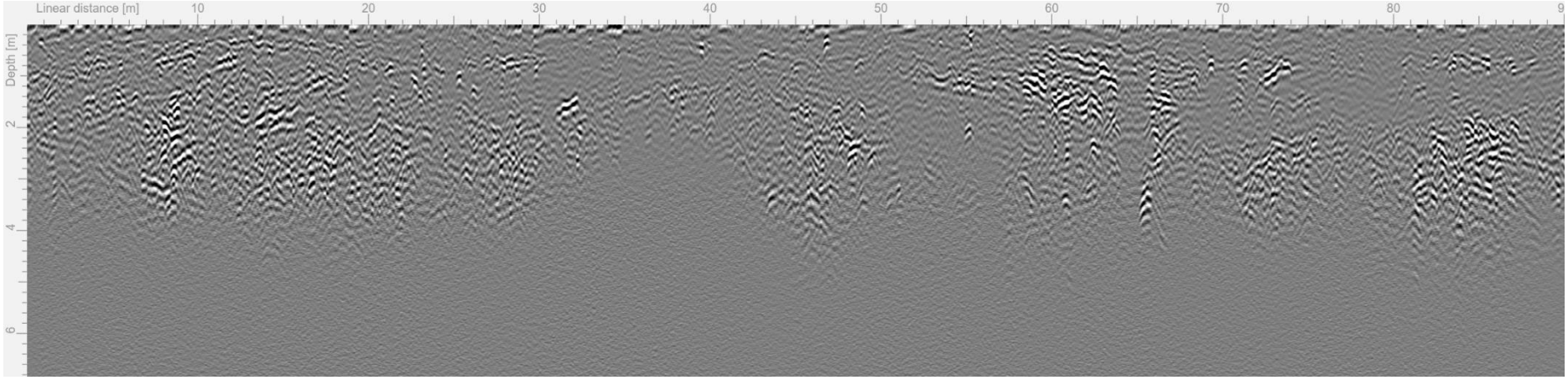

Figure 32 - Castleshaw 2 profile line 49 at X=24 m

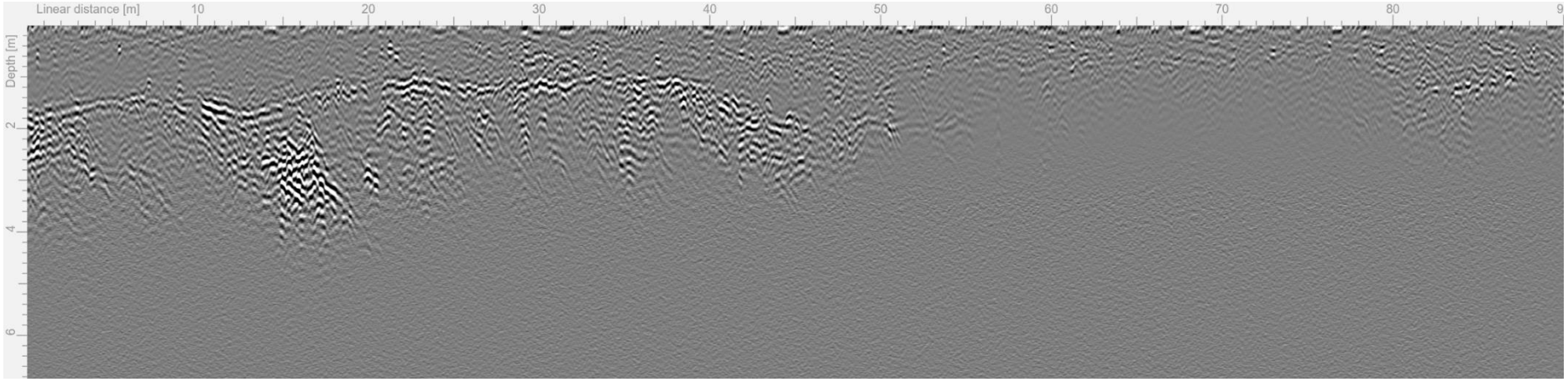

Figure 33 - Castleshaw 3 profile line 21 at X=10.5 m

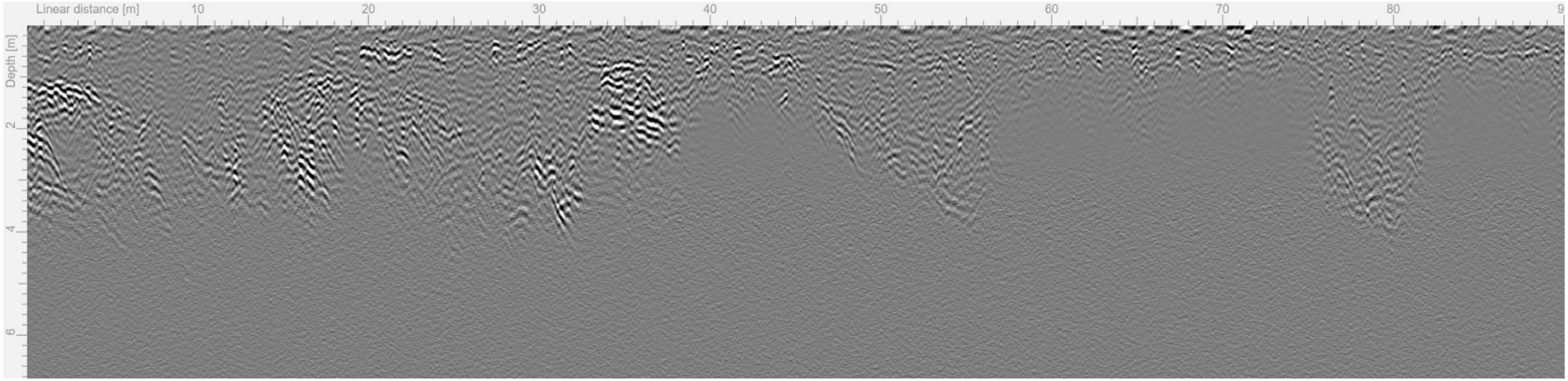

Figure 34 - Castleshaw 3 profile line 45 at X=22.5 m showing quarries at Y=55 m and Y=80 m

The data collected in the longitudinal direction at 500 mm nominal spacing were then cross-checked with the data collected at 250 mm in the transverse direction. These data were collected over a smaller area 75 m long by 15 m wide (Figure 35, Figure 36, Figure 37, Figure 38).

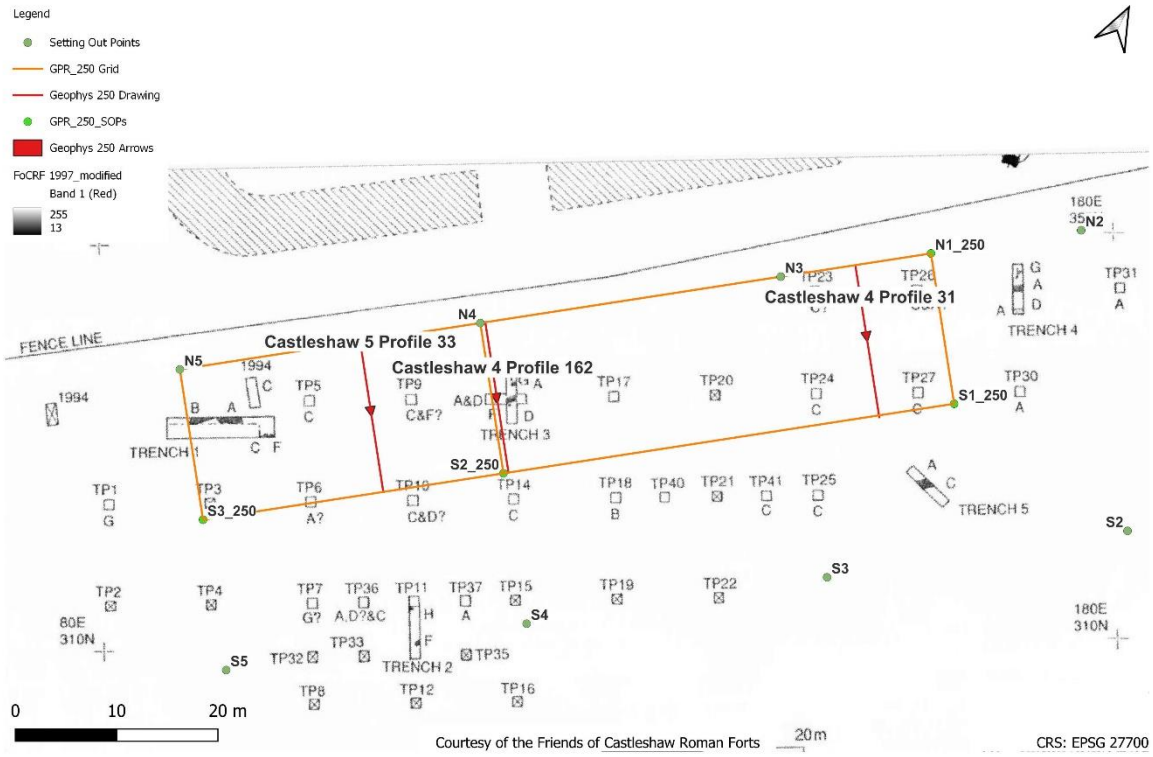

Figure 35 - Selected GPR survey profiles at 250 mm spacing

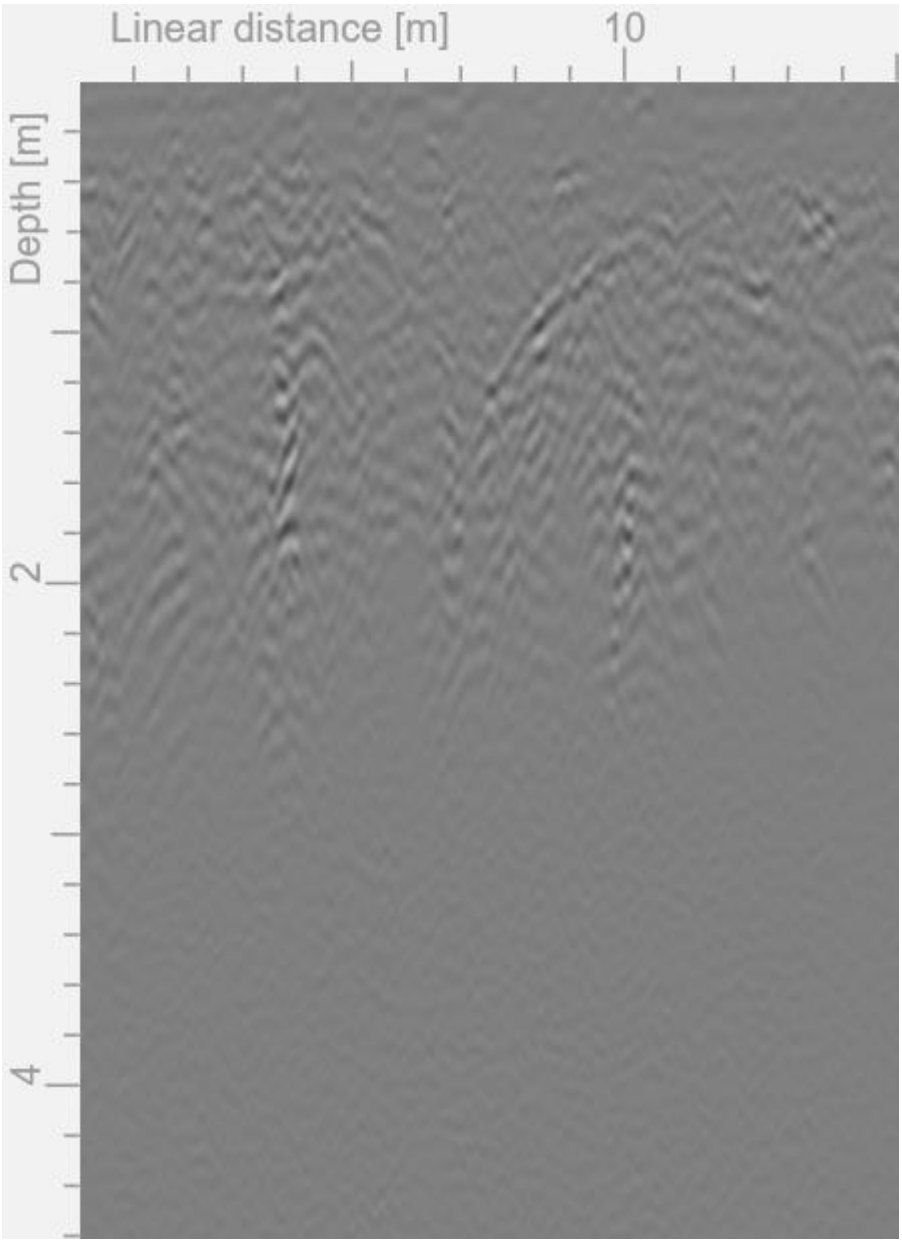

Figure 36 - Castleshaw 4 profile line 31 at Y=-37.5 m showing ditch at X=7.5m

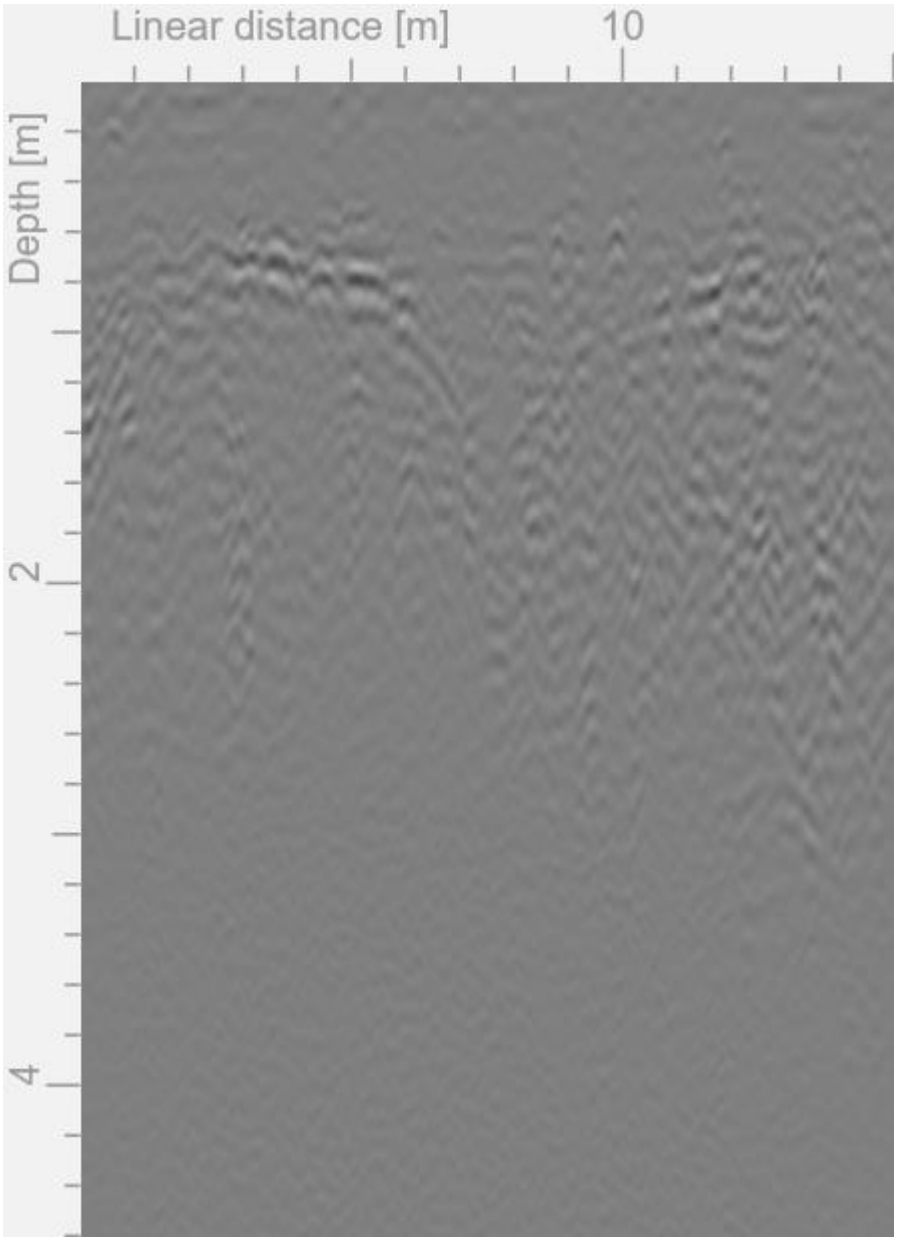

Figure 37 - Castleshaw 4 profile line 162 at Y=-0.5 m showing ditch at X=7.5 m

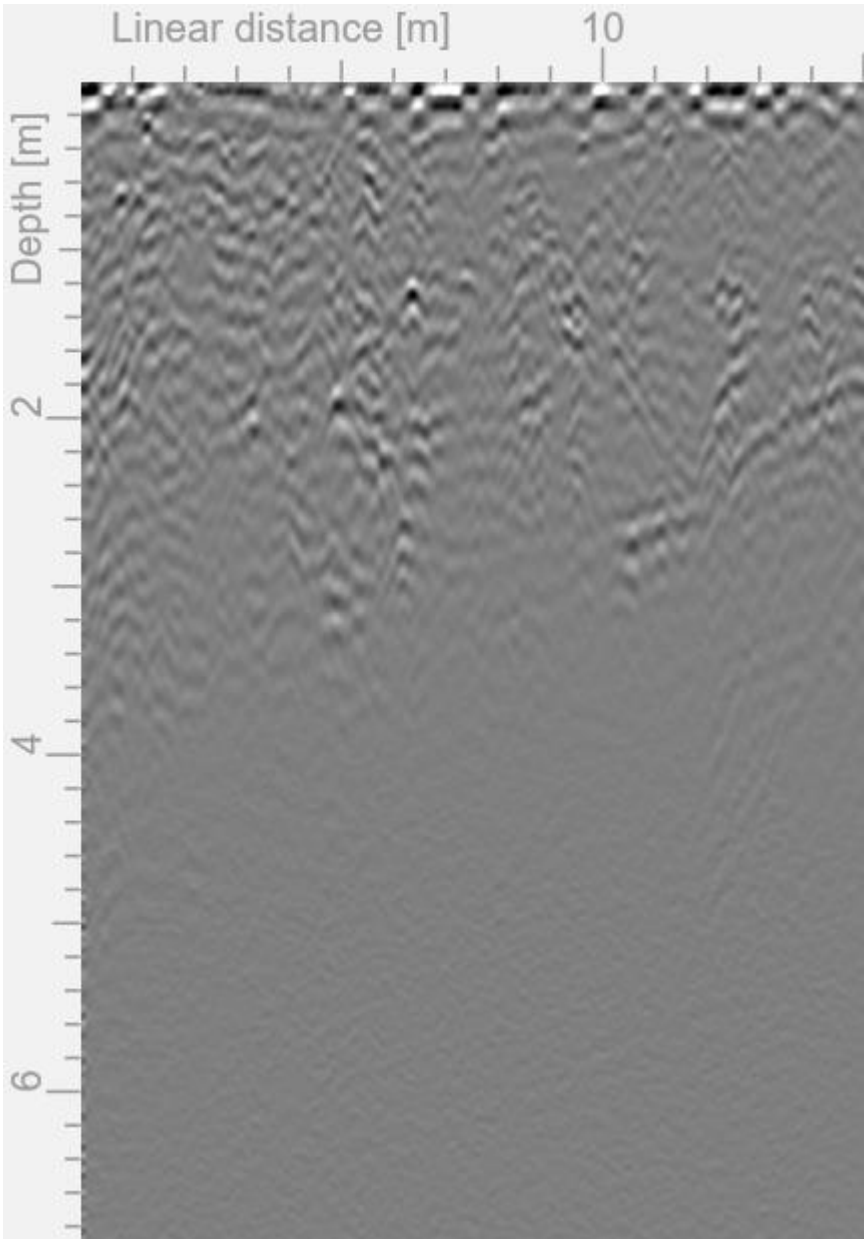

Figure 38 - Castleshaw 5 profile line 33 at Y=8.25 m showing ditch at X=12 m

The data collected at 250 mm traverses were more detailed and therefore overlaid onto the data collected at 500 mm traverses. Overlaying the slices also served as a check on the efficacy of the two methods and good agreement of features was observed. For details of the processing of the data using the Geolitix software see Appendix. The depths of slices are approximate and based on the known depth of the backfill in Trench 3.

The slices at 0.3 m depth are shown in Figure 39.

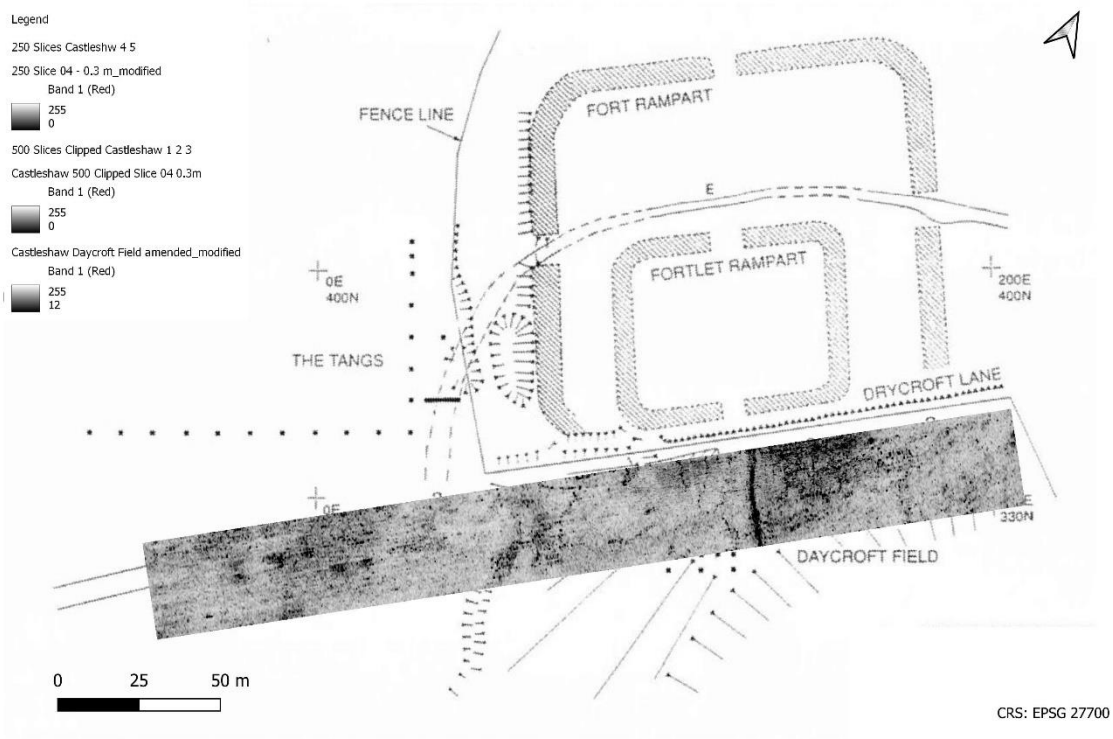

Figure 39 - GPR slice numbers 04 at 0.3 m depth superimposed onto plan of fort

The interpretation of archaeological features at 0.3 m depth is shown in Figure 40 and Table 7. Feature **5000** appears to be a ditch associated with a field boundary observed on Lidar as feature **2103**. Feature **5001** appears to be the upper part of a drainage channel observed on Lidar as feature **2101**. Feature **5002** appears to be ridge and furrow ploughing and is parallel to feature **2100** which was interpreted as a lynchet

.

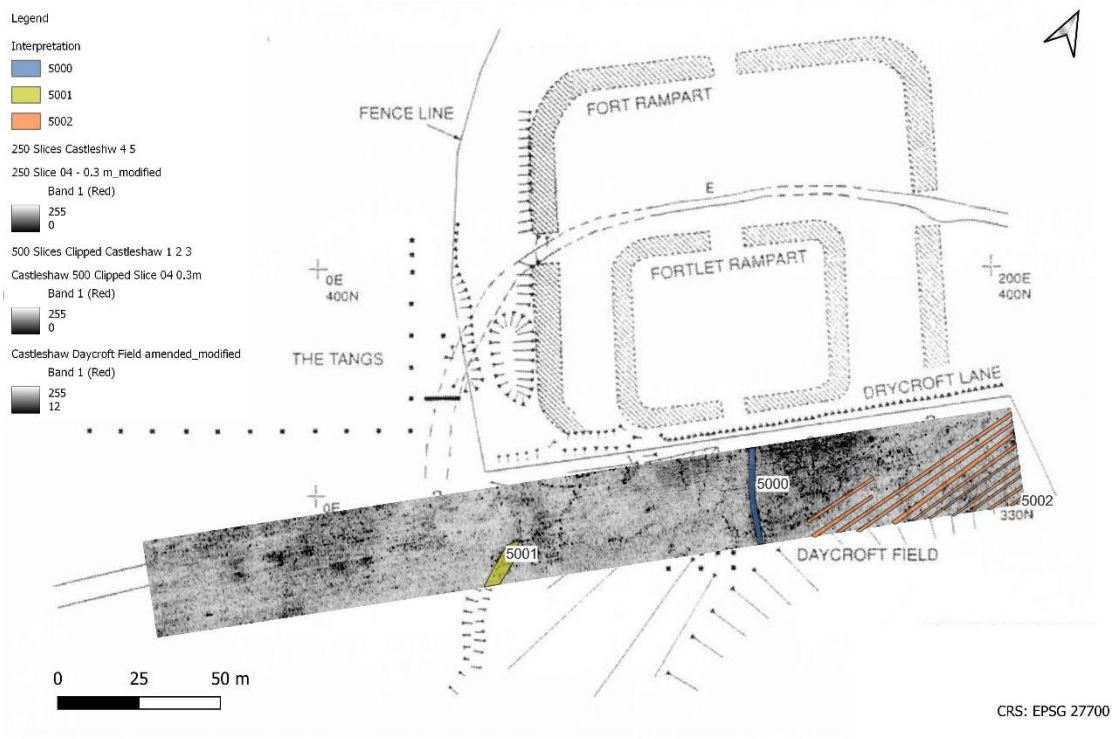

Figure 40 - Interpretation of GPR slice numbers 04 at 0.3 m

Table 7 - GPR data processed using Geolitix software – Interpretation at 0.3 m depth

Feature number	Amplitude	Archaeological interpretation	Certainty of interpretation	Comment
5000	High	Field boundary ditch	Likely	Feature **2103**
5001	Intermediate	Ditch	Likely	Part of feature **2101**
5002	Intermediate	Plough marks	Likely	Parallel to feature **2100**

The slices at 0.6 m depth are shown in Figure 41.

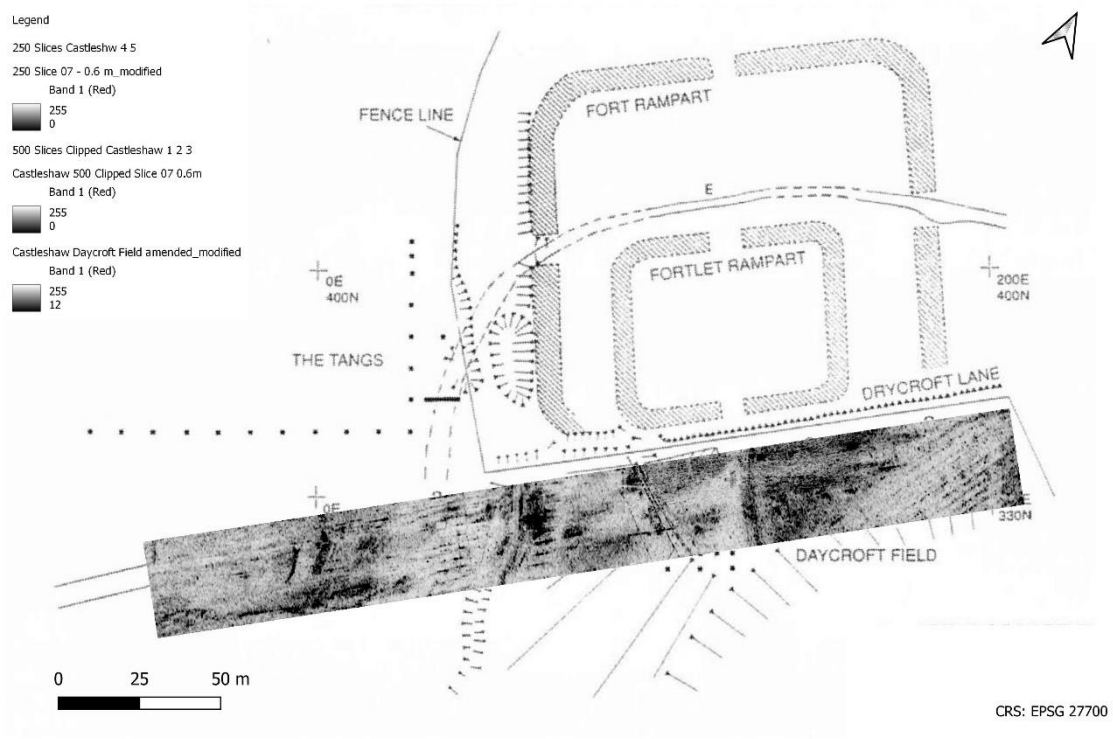

Figure 41 – GPR slice numbers 07 at 0.6 m depth superimposed onto plan of fort

The interpretation of archaeological features at 0.6 m depth is shown in Figure 42 and Table 8. Features **5101** and **5113** are interpreted as ditch infill and evidence of Road 712. Features **5100** and **5108** are interpreted as the walls and fill respectively of a drainage channel. Feature **5102** is interpreted as a series of drains with capping stones, one of which was observed as F003 cutting into the Roman layers in Trench 1 of the 1995 excavations (Redhead, 1996). Feature **5117** is interpreted as modern field drains based on the observation of vitrified clay pipe fragments in mole hills in the area.

Feature **5103** is interpreted as plough marks and are parallel to the present field boundary. Feature **5107** is interpreted as ridge and furrow working and a continuation of feature **5002** at 0.3 m depth which was noted as being parallel to the lynchet feature **2100**.

Feature **5115** is interpreted as the backfill of Trench 1 of the 1995 excavations by GMAU. Feature **5104** is interpreted as the backfill of Trench 3 of the 1996 excavations by GMAU.

Feature **5105** is interpreted as a possible Roman building foundation cut by drainage channel feature **5100**.

Features **5106** are problematical as they appear to have been cut by the ditches of Road 712 but may relate to a later quarry track which encountered the ditch fills of Road 712. Feature **5109** may also relate to the ditches of a track associated with quarrying.

Feature **5110** is also problematical and has been interpreted as an infilled drainage channel as it was found to have a depth of over 3 m. It is approximately aligned on the south gate of the Roman forts and may relate to an earlier road heading towards Waters Clough. Feature **5111** is interpreted as part of feature **2003**. This was interpreted as a track which follows a field boundary feature **2103** towards a zigzag terrace and the existing culverted crossing of Waters Clough.

Features **5112**, **5114** and **5116** are interpreted as possible Roman buildings. Feature **5116** appears to have rectangular foundations 7.5 m by 3.0 m. It should be noted that these features are overlapped by features **4004**, **4005** and **4006** from the gradiometer survey.

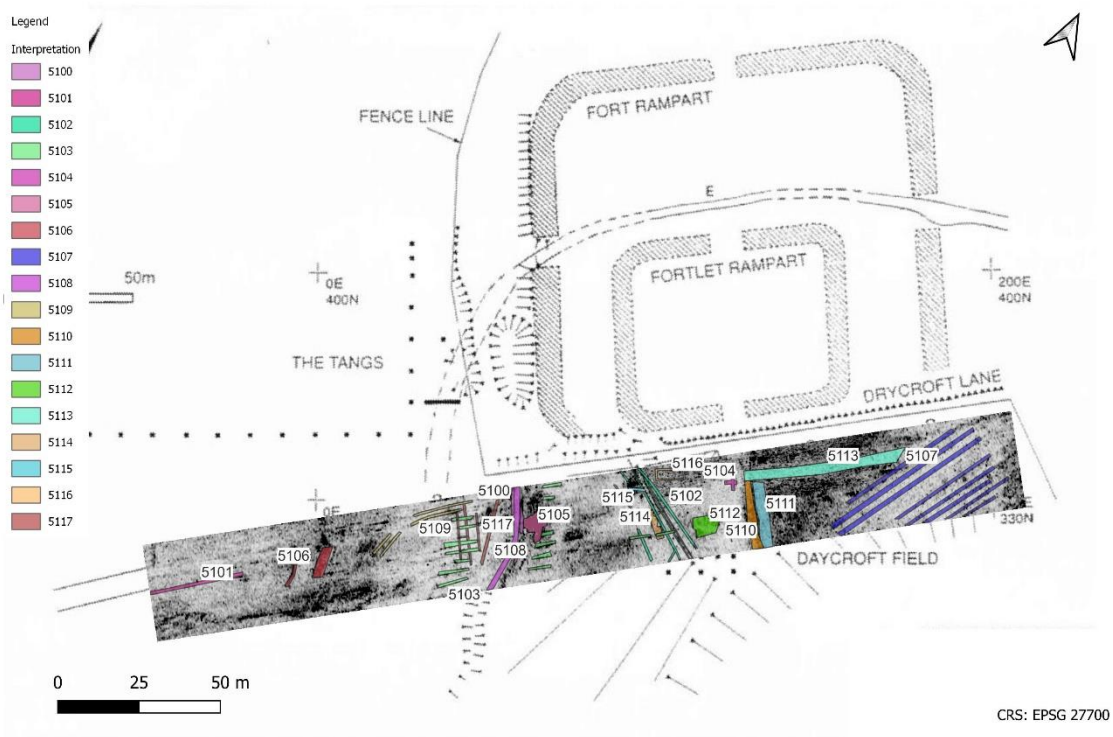

Figure 42 - Interpretation of GPR slice numbers 07 at 0.6 m depth

Table 8 - GPR data processed using Geolitix software – Interpretation at 0.6 m depth

Feature number	Amplitude	Archaeological interpretation	Certainty of interpretation	Comment
5100	Intermediate	Drainage channel wall	Likely	
5101	Low	Ditch fill	Probable	Road 712
5102	High	Stone-capped drain	Likely	Seen as F003 in Trench 1
5103	High	Plough mark	Probable	
5104	High	Trench fill	Likely	Trench 3 1996
5105	High	Building	Possible	
5106	High	Uncertain	Unknown	Geological or quarrying?
5107	High	Ridge and furrow	Probable	
5108	Low	Drainage channel fill	Probable	
5109	High	Quarry track ditch	Probable	
5110	High	Infilled drainage channel	Possible	
5111	Low	Track	Probable	Track to Waters Clough
5112	High	Building	Possible	Roman
5113	Low	Ditch fill	Probable	Road 712
5114	High	Building	Possible	Roman
5115	Low	Trench fill	Probable	Trench 1 1995
5116	High	Rectangular building	Probable	Roman
5117	High	Land drain	Likely	Modern

The slices at 0.9 m depth are shown in Figure 43.

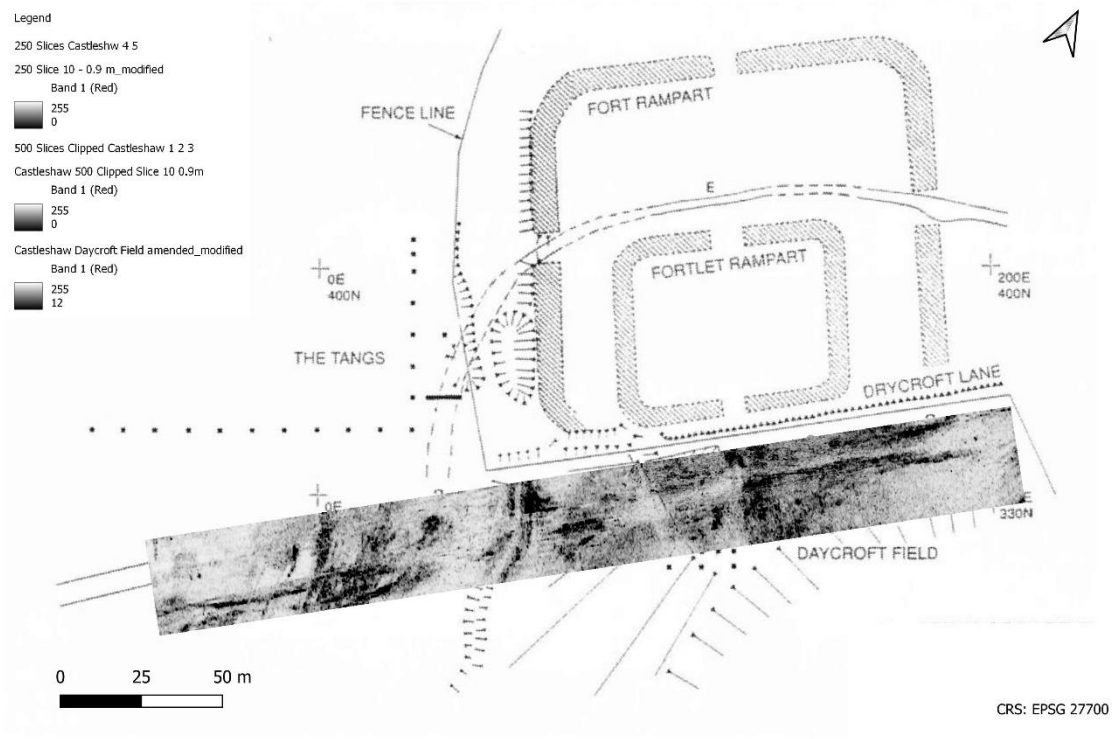

Figure 43 – GPR slice numbers 10 at 0. 9 m depth superimposed onto plan of fort

The interpretation of archaeological features at 0.9 m depth is shown in Figure 44 and Table 9. At the western end of the slice feature **5200** represents a series of quarries. Feature **5201** has been interpreted as a track serving the quarries.

Feature **5202** represents a building to the east of the drainage channel represented by feature **5203** (cut) and **5204** (fill). The drainage channel is a continuation of features **5100** and **5108** at 0.6 m depth. Feature **5205** represents land drains and the partial continuation of feature **5102** detected at 0.6 m depth.

Linear feature **5206** is interpreted as roadside ditches, one of which is represented by F080 of Trench 3 of the 1996 excavations. The fill of this trench is interpreted as feature **5207**. Linear features **5208** and **5209** are interpreted as the southern road ditch of Road 712 and the loop road into the west gate of the fort respectively. The convergence of these features suggests that the loop road is a later diversion of Road 712. Feature **5211** is interpreted as the metalling of the carriageway of Road 712 and features **5212** and **5213** are interpreted as the fill of a southern ditch to Road 712.

Feature **5210** is interpreted as a building which corresponds to the occupation layer found in Test Pit 5 of the 1995 excavations.

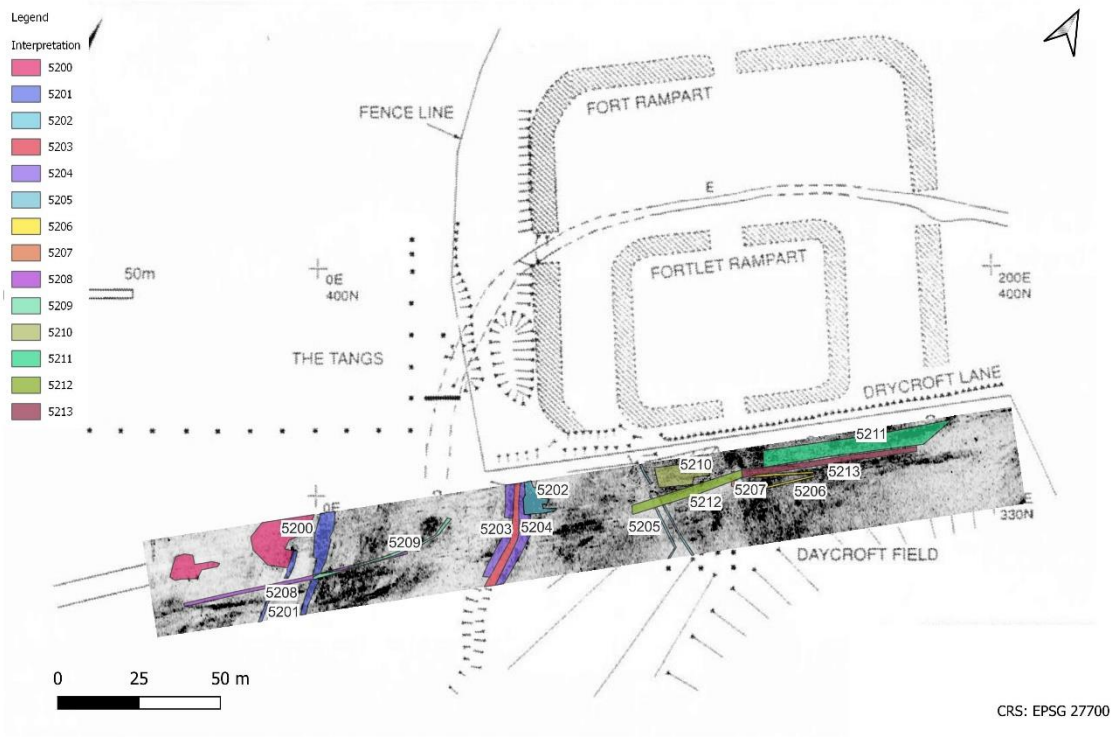

Figure 44 - Interpretation of GPR slice numbers 10 at 0.9 m depth

Table 9 - GPR data processed using Geolitix software – Interpretation at 0.9 m depth

Feature number	Amplitude	Archaeological interpretation	Certainty of interpretation	Comment
5200	Intermediate	Quarry fill	Probable	
5201	High	Quarry track	Probable	
5202	High	Building	Probable	
5203	Low	Drainage channel fill	Likely	
5204	High	Drainage channel cut	Likely	
5205	High	Drain	Probable	
5206	High	Track kerb	Probable	
5207	Low	Trench 3 fill	Likely	1996 Excavation backfill
5208	Low	Ditch fill	Probable	Road 712
5209	Low	Ditch fill	Probable	Loop road
5210	High	Building	Probable	
5211	Intermediate	Road carriageway	Possible	Road 712
5212	Low	Ditch fill	Probable	Road 712
5213	Low	Ditch fill	Probable	Road 712

The slices at 1.2 m depth are shown in Figure 45.

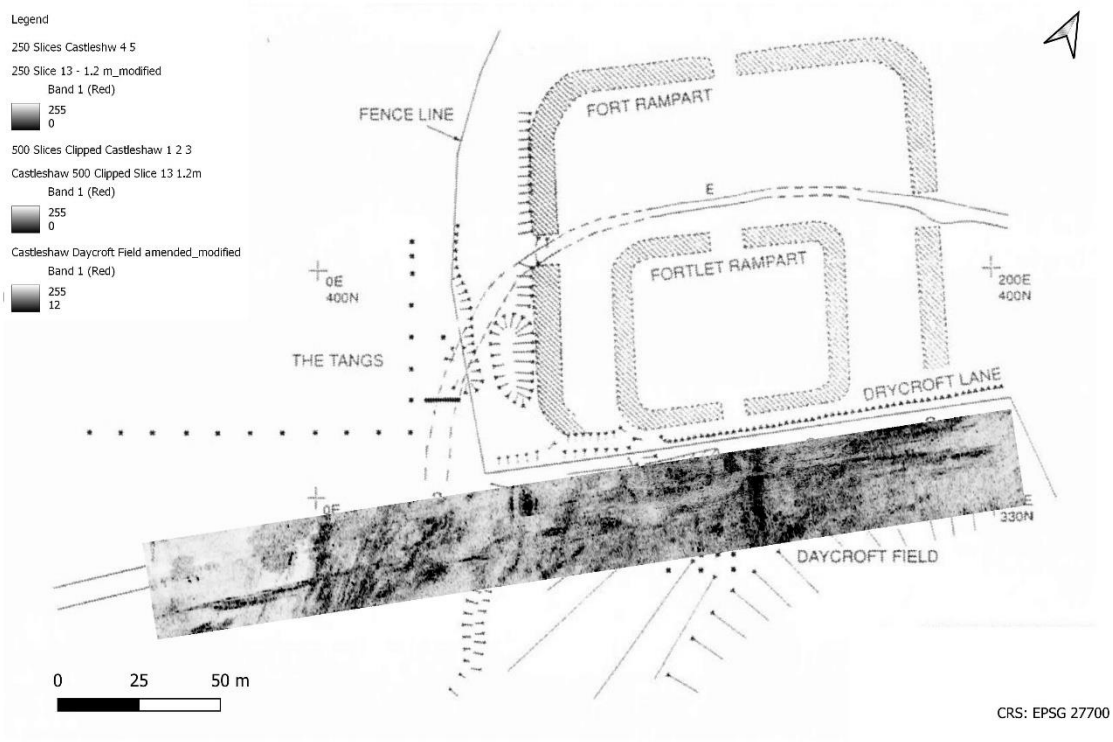

Figure 45 – GPR slice numbers 13 at 1.2 m depth superimposed onto plan of fort

The interpretation of the archaeological features at 1.2 m depth is shown in Figure 46 and Table 10. Feature **5300** is interpreted as the fill of trench 3 of the 1996 excavations and is beginning to fade out at this depth.

Features **5301** and **5310** appear to be related and have a high amplitude response suggestive of stone layers. This interpretation is supported by the high resistance of features **3005** and **3006** on similar alignments. Feature **5301** runs towards Waters Clough from Drycroft lane which also served as a reservoir and has been tentatively interpreted as an infilled drainage channel. Feature **5310** may be an infilled diversion of this drainage channel.

Feature **5302** is interpreted as a platform of a building. Its position south of the south gate of the fort may be significant. Linear features **5307** is interpreted as a building and a continuation of feature **5210** at 0.9 m depth.

The drainage channel represented by feature **5303** (cut) and **5304** (fill) is a continuation of features **5204** and **5203** observed at 0.9 m depth and features **5100** and **5108** at 0.6 m depth.

Linear features **5305** and **5306** are interpreted as the cut and fill respectively of the southern road ditch of Road 712. The high amplitude response of feature **5305** suggests that it may represent the bottom of the ditch in the western part whereas the low response of feature **5306** suggests that the bottom of the ditch has not been reached further to the east. Feature **5311** is interpreted as the fill of a southern ditch to Road 712 and a continuation of feature **5212** at 0.9 m depth. Feature **5312** is interpreted as the metalling of the carriageway of Road 712 and a continuation of feature **5211** at 0.9 m depth.

Feature **5308** is interpreted as the fill of a ditch which was not detected in Trench 1 of the 1995 excavations.

Feature **5309** is interpreted as quarry fill and a continuation of feature **5200** at 0.9 m depth.

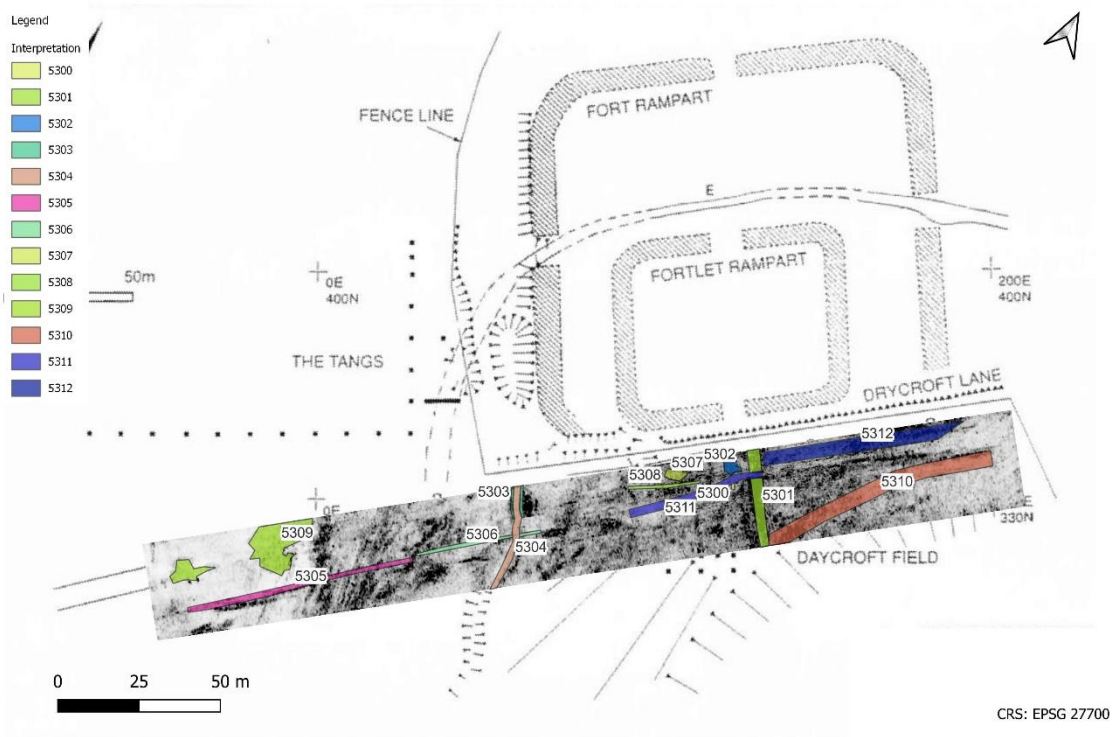

Figure 46 - Interpretation of GPR slice numbers 13 at 1.2 m depth

Table 10 - GPR data processed using Geolitix software – Interpretation at 1.2 m depth

Feature number	Amplitude	Archaeological interpretation	Certainty of interpretation	Comment
5300	Low	Trench 3 backfill	Certain	1996 Excavation
5301	High	Infilled drainage channel	Possible	
5302	High	Building	Possible	
5303	High	Drainage channel cut	Likely	
5304	Low	Drainage channel fill	Likely	
5305	High	Ditch bottom	Probable	Road 712
5306	Low	Ditch fill	Probable	Road 712
5307	High	Building	Possible	
5308	Low	Ditch fill	Probable	
5309	Low	Quarry fill	Probable	
5310	High	Infilled drainage channel	Possible	
5311	Low	Ditch fill	Probable	Road 712
5312	Intermediate	Road carriageway	Possible	Road 712

The slices at 1.5 m depth are shown in Figure 47.

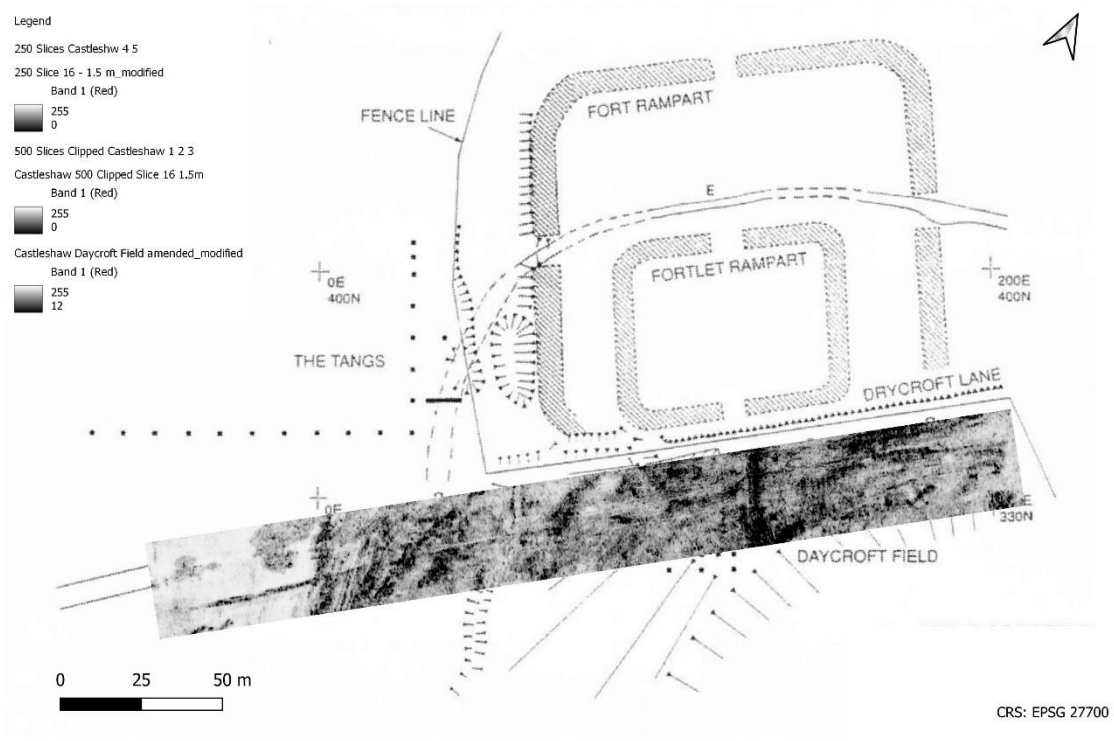

Figure 47 – GPR slice numbers 16 at 1.5 m depth superimposed onto plan of fort

The interpretation of archaeological features at 1.5 m depth is shown in Figure 48 and Table 11. Feature **5401** is an east to west linear high amplitude response which is interpreted as the cut of the south ditch of Road 712. It appears to be contiguous with features **5305** and **5306** at 1.2 m depth and feature **5208** at 0.9 m depth.

The cut and fill of a drainage channel are represented by features **5410** (cut) and **5400** (fill). The cut may be alternatively interpreted as parallel masonry walls of the channel, and this is supported by the interpretation of feature **4001** from the gradiometer survey. This channel is a continuation of features **5303** and **5304** at 1.2 m depth, features **5204** and **5203** observed at 0.9 m depth and features **5100** and **5108** at 0.6 m depth. This feature appears to cut and therefore post-date feature **5401**.

Features **5402** and **5405** are interpreted as buildings and a continuation of feature **5307** at 1.2 m depth and feature **5210** at 0.9 m depth.

Feature **5404** is interpreted as quarry fill and a continuation of feature **5309** at 1.2 m depth and feature **5200** at 0.9 m depth.

Features **5403** and **5406** are interpreted as continuations of the infilled drainage channels represented by features **5301** and **5310** at 1.2 m depth.

Feature **5407** is interpreted as the base of a ditch. It is notable that this feature underlies the track, feature F062 described in Trench 4 and in Test Pit 20 of the 1996 excavations.

Feature **5408** is interpreted as the fill of a southern ditch to Road 712 and a continuation of feature **5311** at 1.2 m depth and feature **5212** at 0.9 m depth.

Feature **5409** is interpreted as the metalling of the carriageway of Road 712 and a continuation of feature **5312** at 1.2 m depth and feature **5211** at 0.9 m depth.

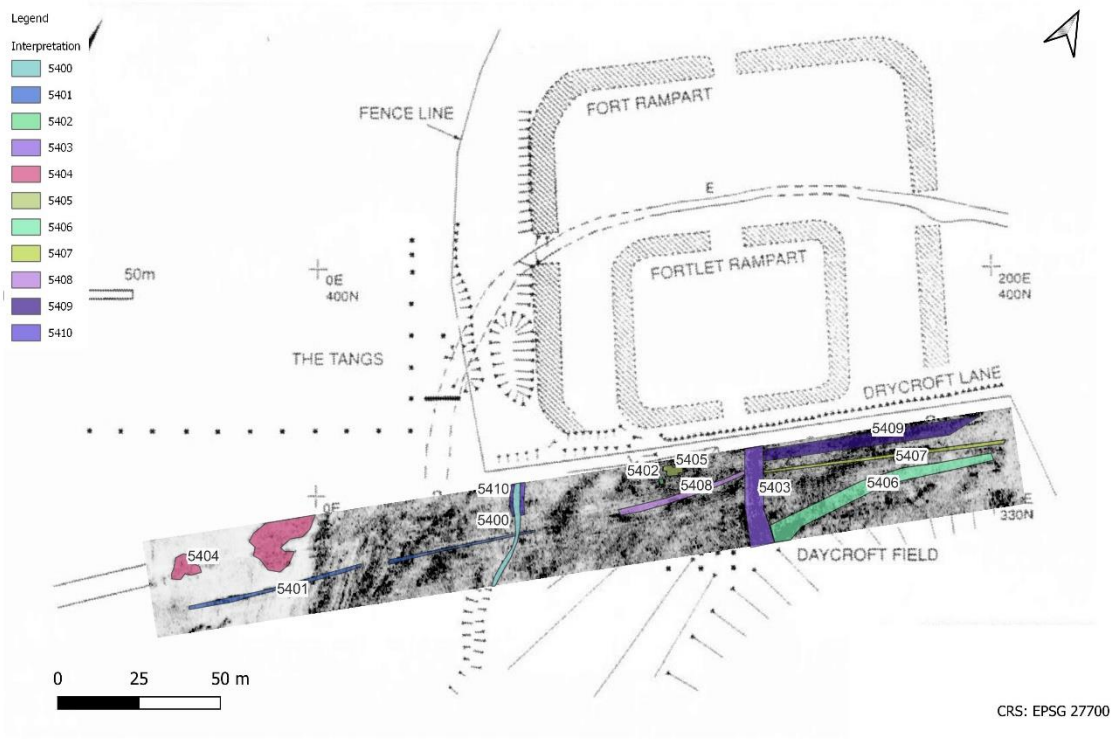

Figure 48- Interpretation of GPR slice numbers 16 at 1.5 m depth

Table 11 - GPR data processed using Geolitix software – Interpretation at 1.5 m depth

Feature number	Amplitude	Archaeological interpretation	Certainty of interpretation	Comment
5400	Low	Drainage channel fill	Likely	
5401	High	Road ditch cut	Probable	Road 712
5402	High	Building	Probable	
5403	High	Infilled drainage channel	Possible	
5404	Low	Quarry fill	Probable	
5405	High	Building	Possible	
5406	High	Infilled drainage channel	Possible	
5407	High	Ditch cut	Probable	
5408	Low	Road ditch fill	Probable	Road 712
5409	Intermediate	Road carriageway	Possible	Road 712
5410	High	Drainage channel cut	Likely	Alternatively, masonry walls

The slices at 1.8 m depth are shown in Figure 49.

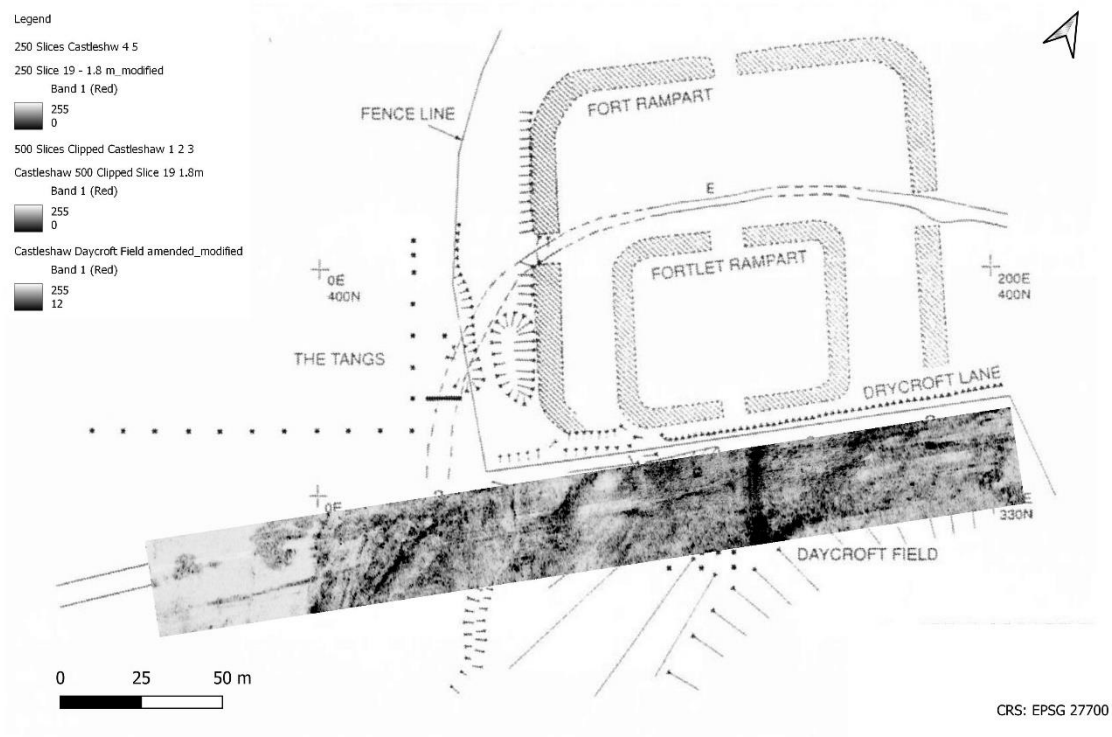

Figure 49 – GPR slice numbers 19 at 1.8 m depth superimposed onto plan of fort

The interpretation of the archaeological features at 1.8 m depth is shown in Figure 50 and summarised in Table 12.

Feature **5500** is interpreted as the cut of the south ditch of Road 712. It appears to be contiguous with feature **5401** at 1.5 m depth, features **5305** and **5306** at 1.2 m depth and feature **5208** at 0.9 m depth.

Feature **5501** is interpreted as a building and is contiguous with feature **5402** at 1.5 m depth, feature **5307** at 1.2 m depth and feature **5210** at 0.9 m depth.

Features **5502** and **5507** are interpreted as continuations of the infilled drainage channels represented by features **5403** and **5406** at 1.5 m depth and features **5301** and **5310** at 1.2 m depth.

Feature **5503** is interpreted as quarry fill and a continuation of feature **5404** at 1.5 m depth, feature **5309** at 1.2 m depth and feature **5200** at 0.9 m depth.

The cut and fill of a drainage channel are represented by features **5504** (cut) and **5505** (fill). The cut may be alternatively interpreted as a masonry wall of the channel which is supported by the interpretation of feature **4001** from the gradiometer survey. This channel is a continuation of features **5410** and **5400** at 1.5 m depth, features **5303** and **5304** at 1.2 m depth, features **5204** and **5203** at 0.9 m depth and features **5100** and **5108** at 0.6 m depth. This feature appears to cut and therefore post-date feature **5500**.

Feature **5506** is interpreted as the metalling of the carriageway of Road 712 and a continuation of feature **5409** at 1.5 m depth, feature **5312** at 1.2 m depth and feature **5211** at 0.9 m depth.

Feature **5508** is interpreted as the fill of a southern ditch to Road 712 and a continuation of feature **5408** at 1.5 m depth, **5311** at 1.2 m depth and feature **5212** at 0.9 m depth.

Feature **5509** is interpreted as the cut of the southern ditch to Road 712 to the east of feature **5502**. The change in alignment of features **5500** and **5508** to the south of Castleshaw fort suggests that this section of Road 712 was constructed after the fort was laid out. In addition, the correction in the alignment of features **5500** and **5508** appears to meet feature **5509.** This suggests that feature **5509** was constructed first and that the section of Road 712 east of Castleshaw fort was constructed before the section of Road 712 immediately west of Castleshaw fort. At Upper Holme the central spine of Road 712 was observed to have been laid out from west to east (Lunn et al., 2008, p. 24) and it is possible that this section of Road 712 was constructed from Castleshaw fort eastwards towards Slack fort.

It is notable that feature **5502** cuts features **5508** and **5509** and therefore postdates the construction of Road 712.

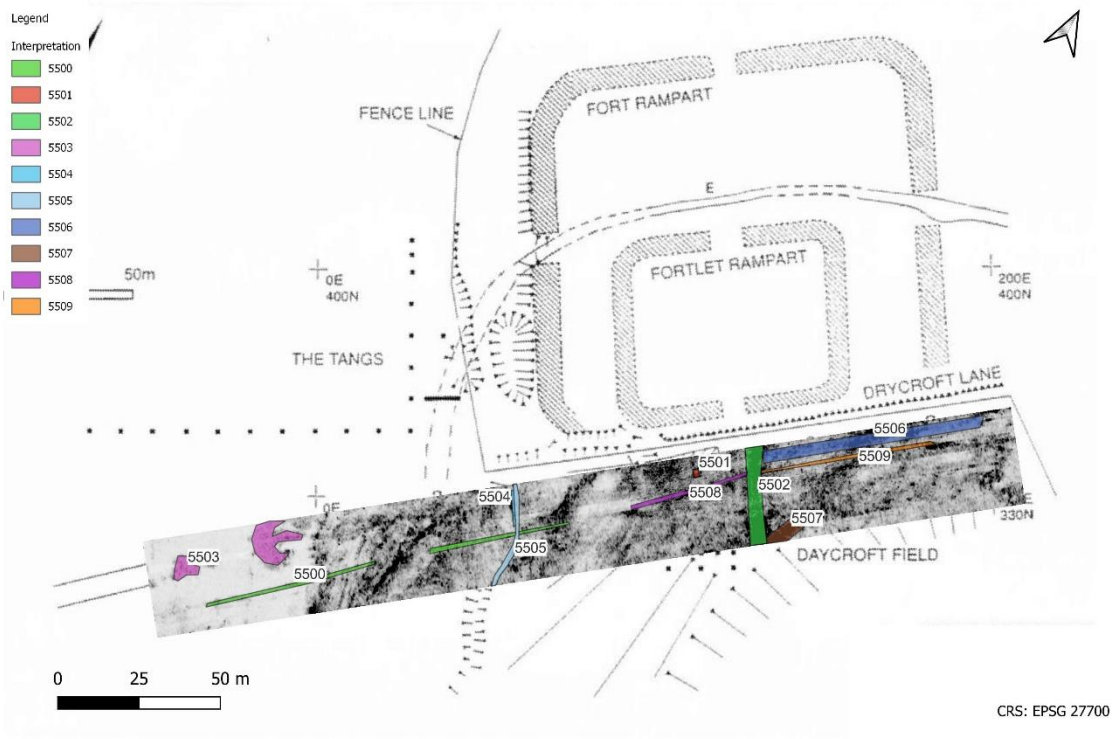

Figure 50 - Interpretation of GPR slice numbers 19 at 1.8 m depth

Table 12 - GPR data processed using Geolitix software – Interpretation at 1.8 m depth

Feature number	Amplitude	Archaeological interpretation	Certainty of interpretation	Comment
5500	High	Road ditch cut	Probable	Road 712
5501	High	Building	Probable	
5502	High	Infilled drainage channel	Possible	
5503	Low	Quarry fill	Probable	
5504	High	Ditch cut	Likely	Alternatively, masonry wall
5505	Low	Drainage channel fill	Likely	
5506	Intermediate	Road carriageway	Possible	Road 712
5507	High	Infilled drainage channel	Possible	
5508	Low	Road ditch fill	Probable	Road 712
5509	High	Road ditch cut	Probable	Road 712

The slices at 2.1 m depth are shown in Figure 51.

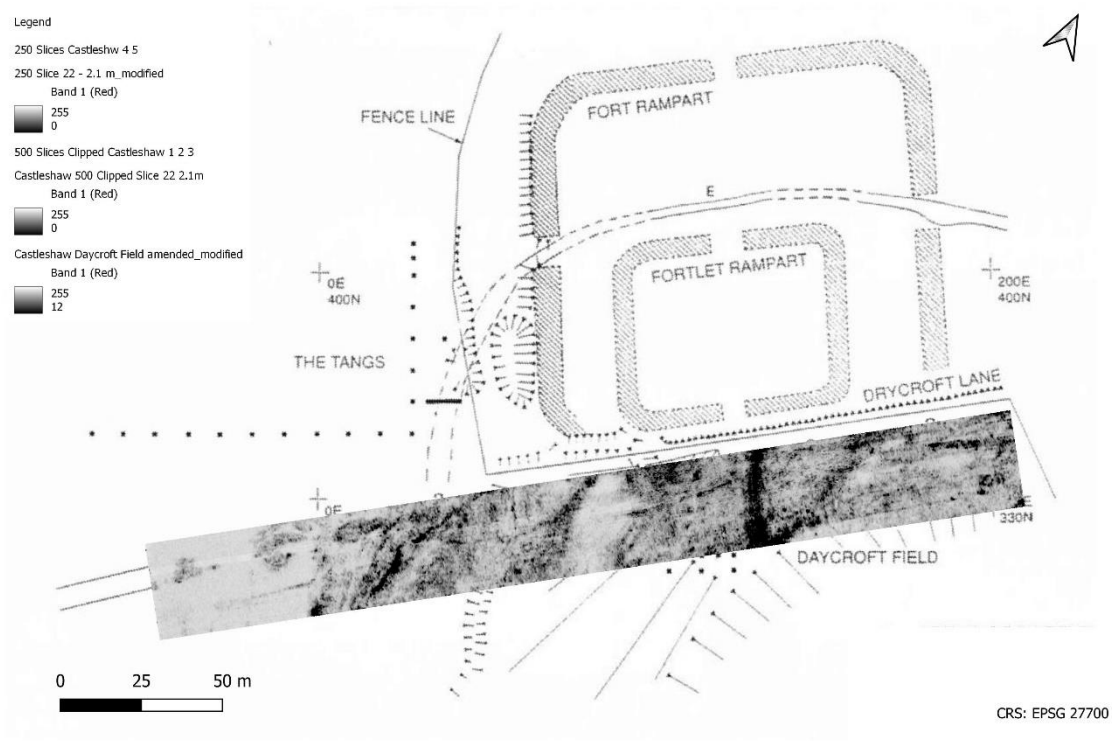

Figure 51 – GPR slice numbers 22 at 2.1 m depth superimposed onto plan of fort

The interpretation of the archaeological features at 2.1 m depth is shown in Figure 52 and Table 13. Features **5600** and **5606** are interpreted as continuations of the infilled drainage channels represented by features **5502** and **5507** at1.8 m depth, **5403** and **5406** at 1.5 m depth and features **5301** and **5310** at 1.2 m depth.

Feature **5601** is interpreted as a building and is contiguous with feature **5501** at 1.8 m depth, feature **5402** at 1.5 m depth, feature **5307** at 1.2 m depth and feature **5210** at 0.9 m depth.

Feature **5602** is interpreted as quarry fill and a continuation of feature **5503** at 1.8 m depth, feature **5404** at 1.5 m depth, feature **5309** at 1.2 m depth and feature **5200** at 0.9 m depth.

Feature **5603** is interpreted as the cut of the south ditch of Road 712. It appears to be contiguous with feature **5500** at 1.8 m depth, feature **5401** at 1.5 m depth, features **5305** and **5306** at 1.2 m depth and feature **5208** at 0.9 m depth.

Feature **5604** is interpreted as the walls of a building and lie below and therefore predate features **5500** and **5504** at 1.8 m level. The main cell of the building appears to be

approximately 17.5 m long and 5.5 m wide with an apsidal south end of approximately 2.75 m radius. Two rectangular features are interpreted as possible walls approximately 2.5 m by 2.0 m and offset by 2m and 3m from the apsidal feature.

Feature **5605** is interpreted as the fill of the south ditch to Road 712 and a continuation of feature **5508** at 1.8 m depth, feature **5408** at 1.5 m depth, **5311** at 1.2 m depth and feature **5212** at 0.9 m depth.

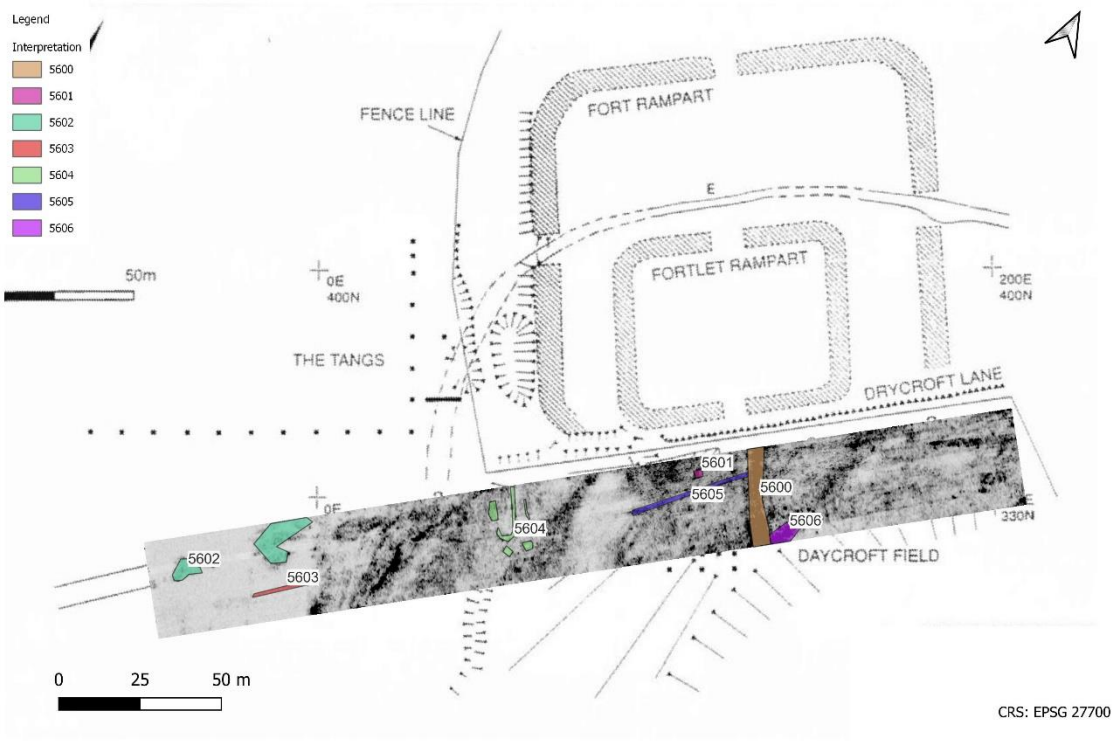

Figure 52 - Interpretation of GPR slice numbers 22 at 2.1 m depth

Table 13 - GPR data processed using Geolitix software – Interpretation at 2.1 m depth

Feature number	Amplitude	Archaeological interpretation	Certainty of interpretation	Comment
5600	High	Infilled drainage channel	Possible	
5601	High	Building	Possible	
5602	Low	Quarry fill	Probable	
5603	High	Ditch cut	Probable	Road 712
5604	High	Building	Possible	
5605	High	Ditch cut	Probable	Road 712
5606	High	Infilled drainage channel	Possible	

The slices at 2.4 m depth are shown in Figure 53.

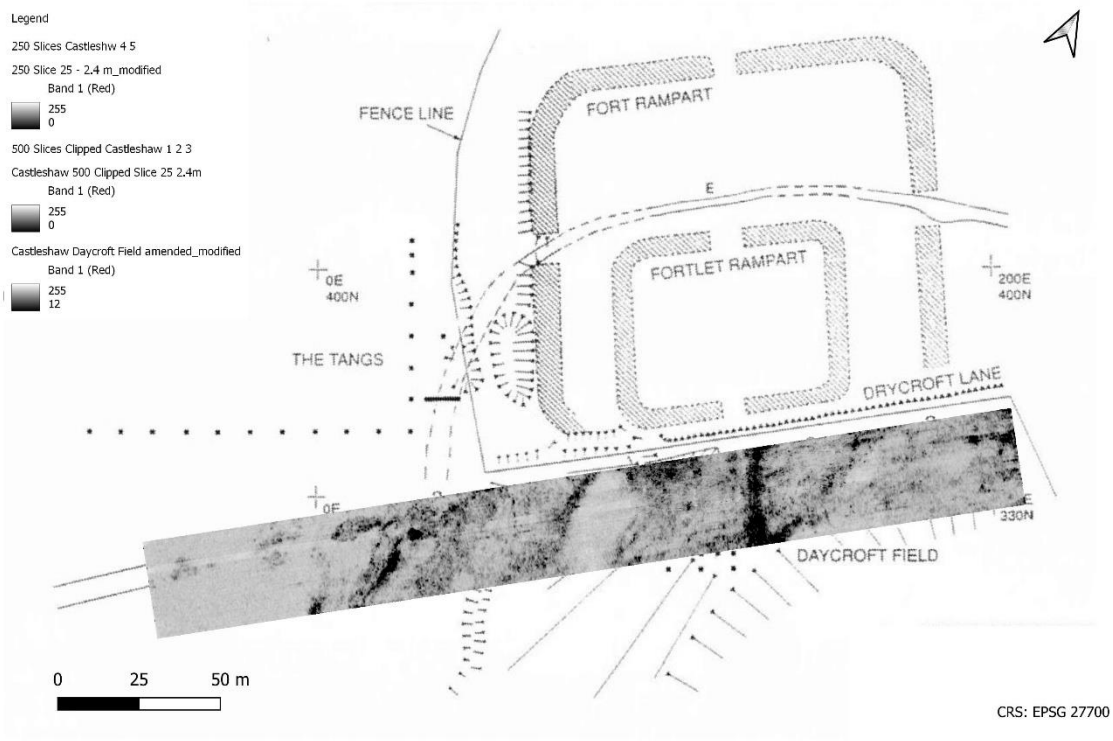

Figure 53 - GPR slice numbers 25 at 2.4 m depth superimposed onto plan of fort

The interpretation of the archaeological features at 2.4 m depth is shown in Figure 54, and is summarised in Table 14.

Features **5700** and **5704** are interpreted as continuations of the infilled drainage channels represented by features **5600** and **5606** at 2.1 m depth, features **5502** and **5507** at 1.8 m depth, 5403 and 5406 at 1.5 m depth and features **5301** and **5310** at 1.2 m depth.

Feature **5701** is interpreted as a building and is contiguous with feature **5601** at 2.1m depth, feature **5501** at 1.8 m depth, feature 5402 at 1.5 m depth, feature **5307** at 1.2 m depth and feature **5210** at 0.9 m depth.

Feature **5702** is interpreted as quarry fill and a continuation of feature **5602** at 2.1 m depth, feature **5503** at 1.8 m depth, feature **5404** at 1.5 m depth, feature **5309** at 1.2 m depth and feature **5200** at 0.9 m depth.

Feature **5703** is interpreted as an L-shaped wall with the longer wall abutting the eastern wall of the main cell of feature **5604** at 2.1 m depth. Note that one of the 2.5 m by 2.0 m

rectangular cells of feature **5604** lies on the longitudinal axis of this feature and is offset 3.5 m from the shorter wall of feature **5701**.

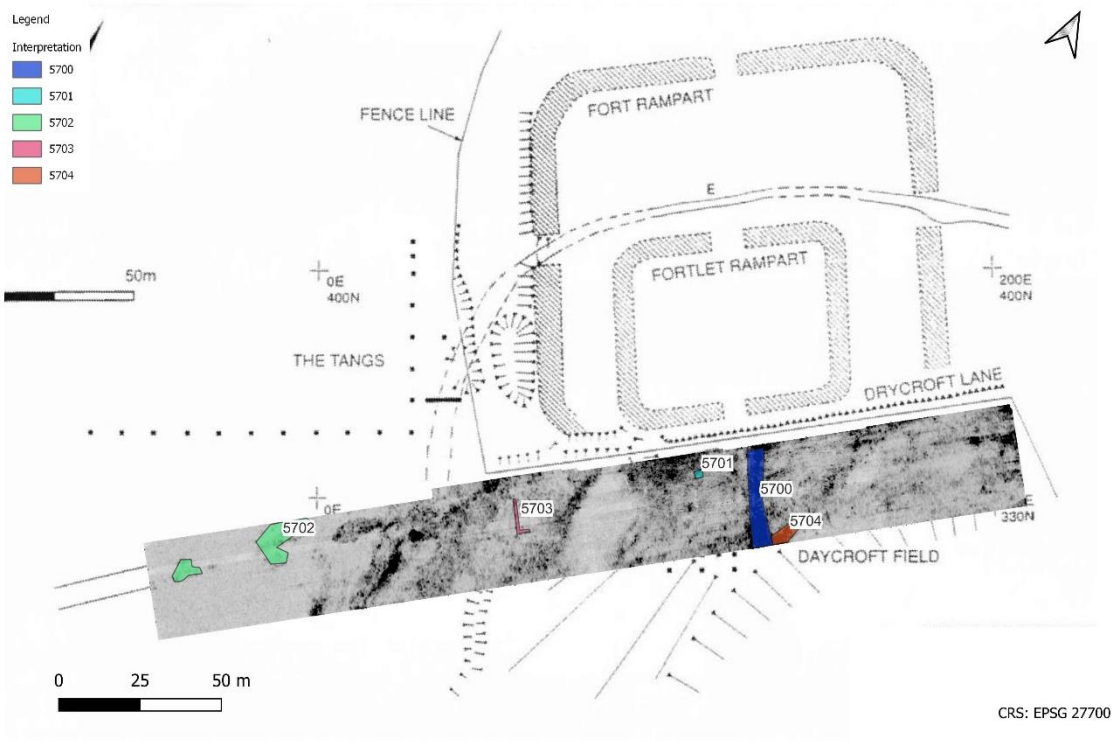

Figure 54 - Interpretation of GPR slice numbers 25 at 2.4 m depth

Table 14 - GPR data processed using Geolitix software – Interpretation at 2.4 m depth

Feature number	Amplitude	Archaeological interpretation	Certainty of interpretation	Comment
5700	High	Infilled drainage channel	Possible	
5701	High	Wall of building	Possible	
5702	Intermediate	Quarry fill	Probable	
5703	High	Building	Possible	
5704	High	Infilled drainage channel	Possible	

Summary of Geophysical Survey Interpretations by Feature Type

The geophysical survey interpretations have been summarised below by feature type i.e. roads, buildings, drainage, quarrying and agricultural.

There appear to be at least three periods of roads (Figure 55, Table 15).

Feature numbers **6000**, **6001**, **6002** and **6006** are interpreted as the initial phase of Road 712 from Manchester fort. Features **6005** and **6008** are interpreted as the corresponding initial phase of Road 712 from Slack fort.

The diversion of Road 712 loop road by the loop road is attested by features **6004** and **6007**. The construction of the loop road could have allowed the building of tracks over the abandoned line of Road 712 and serving the area to the south of the fort and is attested by feature **6003**.

Features **6009** and **6010** are tentatively interpreted as post-medieval tracks.

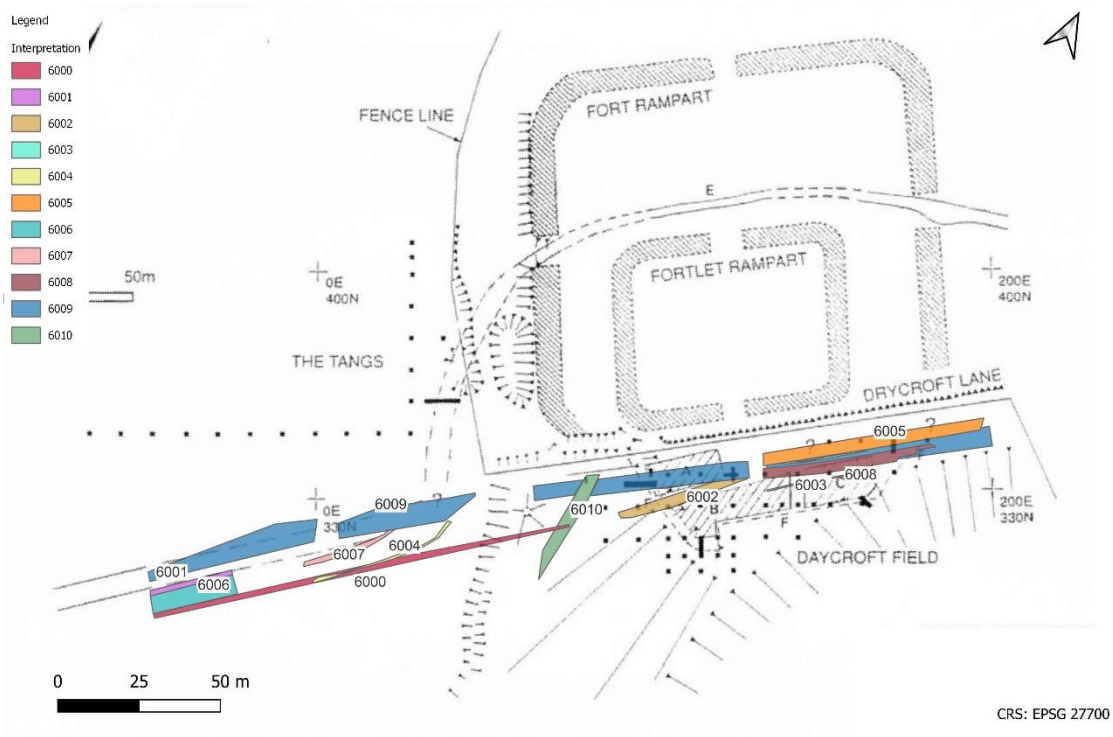

Figure 55 – Geophysical interpretation of roads and ditches

Table 15 – Summary of geophysical interpretation of roads and ditches

Composite feature number	Archaeological interpretation	Certainty of interpretation	Occurrence depth (m) - GPR only	**Feature numbers**
6000	Road 712 south ditch	Likely	0.9, 1.2, 1.5, 1.8, 2.1	**5208, 5305, 5306, 5401, 5500, 5603**
6001	Road 712 north ditch	Probable	0.6	**5101**
6002	Road 712 south ditch	Probable	0.9, 1.2, 1.5, 1.8, 2.1	**5212, 5311, 5408, 5508, 5605**
6003	Track ditch	Probable	0.9, 1.2	**5206, 5305**
6004	Loop road south ditch	Probable	0.9	**4002, 5209**
6005	Road 712 carriageway	Possible	0.9, 1.2, 1.5, 1.8	**5211, 5312, 5409, 5506**
6006	Road 712 carriageway	Possible		**3000**
6007	Loop road north ditch	Probable		**4000**
6008	Road 712 south ditch	Probable	0.6, 0.9, 1.8	**5113, 5213, 5509**
6009	Track	Probable		**3001, 3004**
6010	Track	Probable		**3002**

The buildings that have been interpreted are all assigned to the Roman period (Figure 56, Table 16). Features **6101** and **6106** are notable as the depth of their remains extend to approximately 2.4 m. Feature **6105** appears to be a rectangular feature approximately 1.5 m square inside a building (feature **6104**).

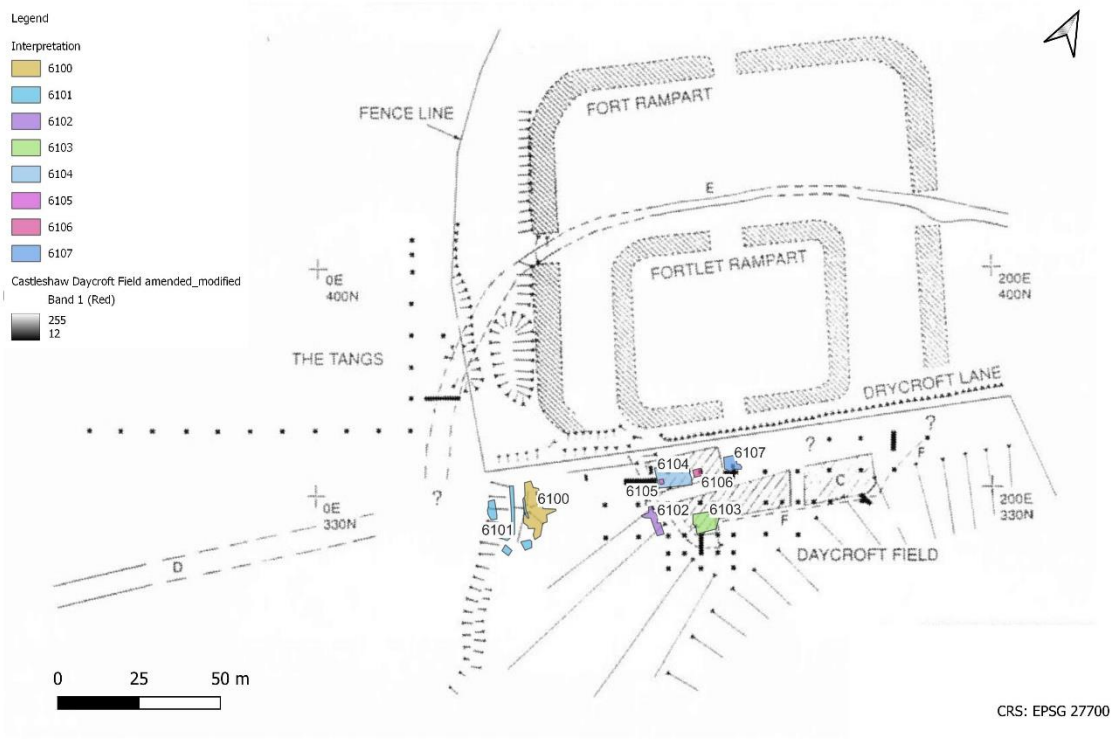

Figure 56 - Geophysical interpretation of buildings

Table 16 – Summary of geophysical interpretation of buildings

Composite feature number	Archaeological interpretation	Certainty of interpretation	Occurrence depth (m)	**Feature numbers**
6100	Building	Possible	0.6, 0.9	**5105, 5202**
6101	Building	Possible	2.1, 2.4	**5604, 5713**
6102	Building	Possible	0.6	**5114**
6103	Building	Possible	0.6	**5112**
6104	Building	Possible	0.6, 0.9, 1.2, 1.5	**5116, 5210, 5307, 5405**
6105	Feature inside **6104**	Possible	1.5	**5402**
6106	Building	Possible	1.8, 2.1, 2.4	**5501, 5601, 5701**
6107	Building	Possible	1.2	**5302**

The drainage features that have been interpreted (Figure 57, Table 17) include features **6203** and **6205** which have been tentatively identified as infilled drainage channels and dated to the Post-medieval period. Features **6200**, **6201** and **6202** have also been interpreted as a Post-medieval drainage channel, however, an association with Roman period feature **6101** is possible as the long walls of this feature align closely with the channel. Feature **6204** is likely to be a series of drains with capping stones and is interpreted as Post-medieval. Feature **6206** is interpreted as modern land-drains.

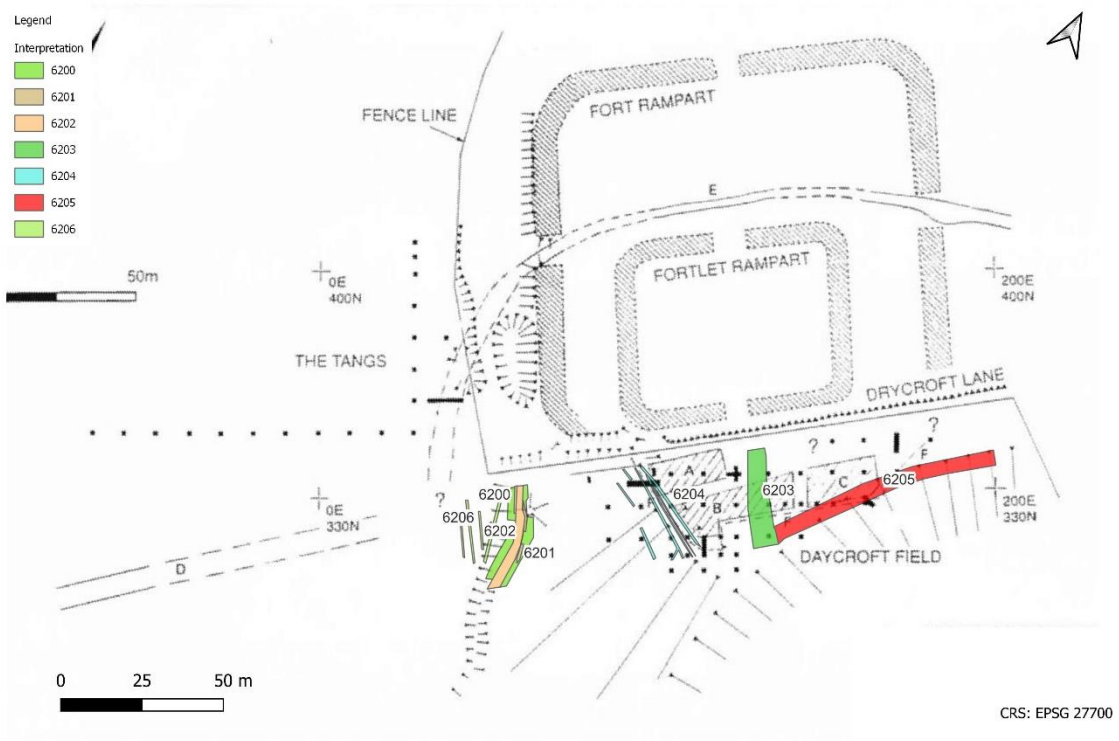

Figure 57 – Geophysical interpretation of drainage features

Table 17 – Summary of geophysical interpretation of drainage features

Composite feature number	Archaeological interpretation	Certainty of interpretation	Occurrence depth (m) - GPR only	**Feature numbers**
6200	Drainage channel cut	Likely	0.9	**3008, 5204**
6201	Drainage channel wall	Likely	0.6, 1.2, 1.5, 1.8	**4001, 5100, 5303, 5410, 5504**
6202	Drainage channel fill	Likely	0.3, 0.6, 0.9, 1.2, 1.5, 1.8	**5001, 5108, 5203, 5304, 5400, 5505**
6203	Infilled drainage channel	Possible	0.3, 0.6, 1.2, 1.5, 1.8, 2.1, 2.4	**3006, 5000, 5110, 5301, 5403, 5502, 5600, 5700**
6204	Drains	Likely	0.6, 0.9	**5102, 5205**

6205	Infilled Drainage Channel	Possible	1.2, 1.5, 1.8, 2.1, 2.4	**3005, 5310, 5406, 5507, 5606, 5704**
6206	Drains	Likely	0.6	**5117**

The quarrying features that have been interpreted are all assigned to the Post-medieval period and are concentrated at the southwest corner of the fort (Figure 58, Table 18). The quarrying activity is likely to have slighted Road 712 to some extent.

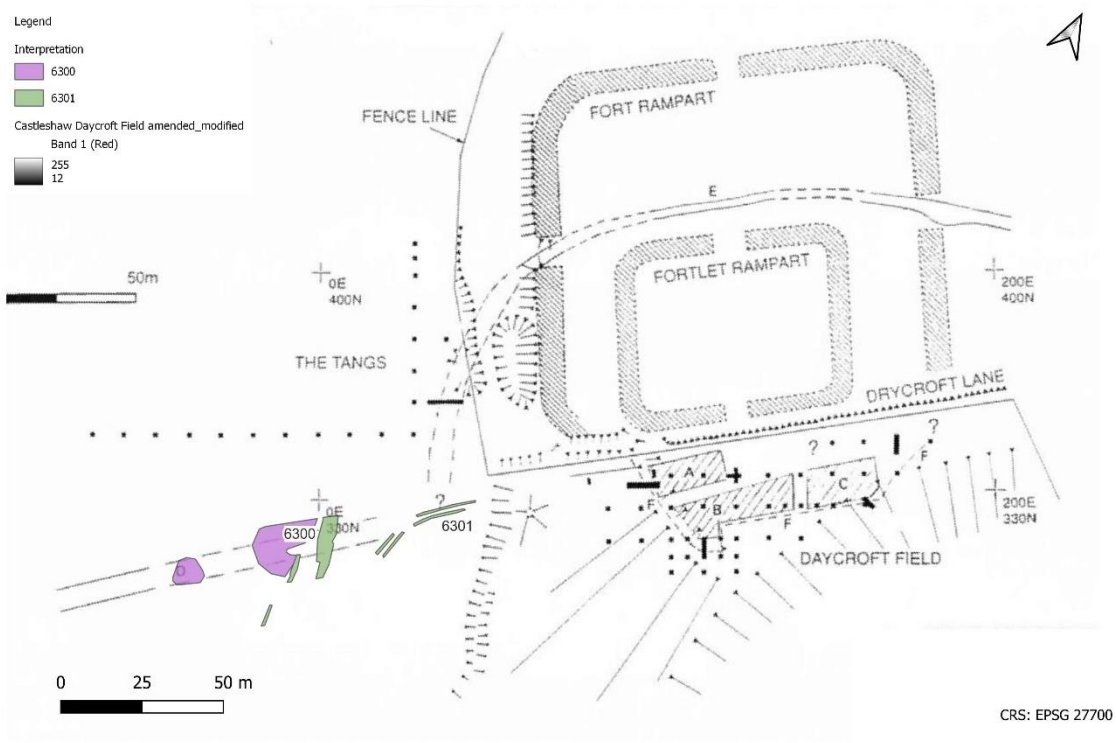

Figure 58 - Geophysical interpretation of quarrying features

Table 18 – Summary of geophysical interpretation of quarrying features

Composite feature number	Archaeological interpretation	Certainty of interpretation	Occurrence depth (m) - GPR only	**Feature numbers**
6300	Quarries	Likely	0.9, 1.2, 1.5, 1.8, 2.1, 2.4	**2107, 5200, 5309, 5404, 5503, 5602, 5702**
6301	Quarry tracks	Probable	0.6, 0.9	**5106, 5109, 5201**

Agricultural feature **6400** has been interpreted (Figure 59, Table 19) as dating to the Post-medieval period as it is not parallel to the present-day field boundaries. Feature **6401** is interpreted as dating to the modern period as it is parallel to the present field boundaries.

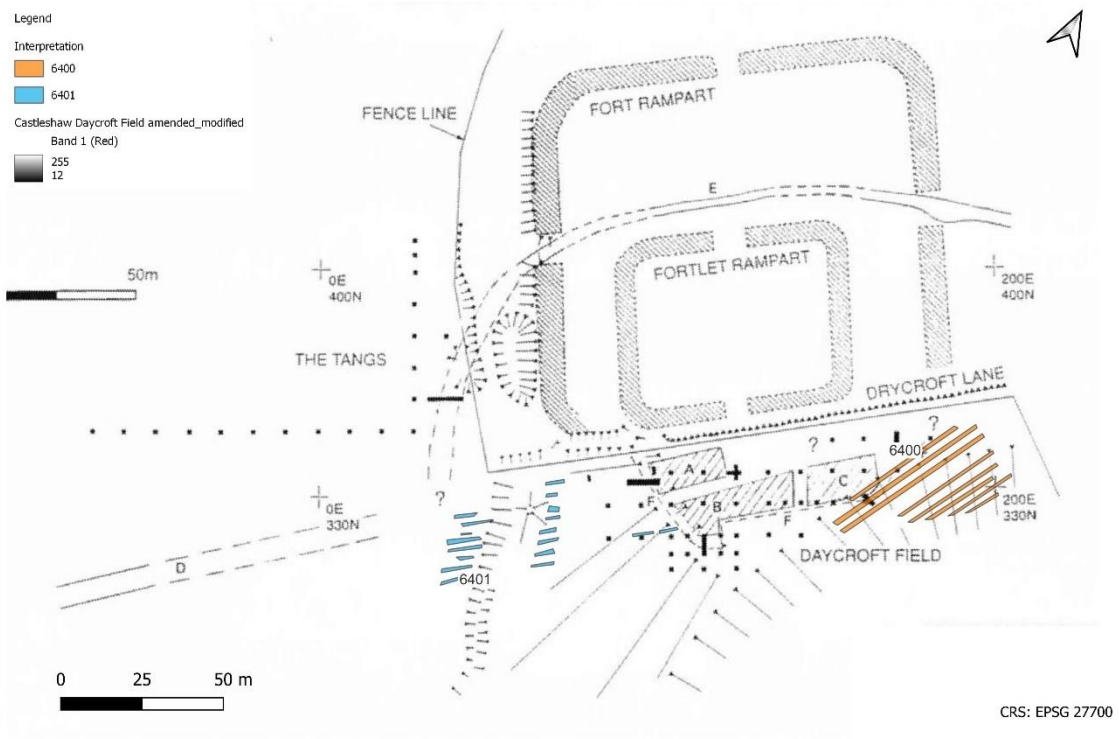

Figure 59 – Geophysical interpretation of agricultural features

Table 19 – Summary of geophysical interpretation of agricultural features

Composite feature number	Archaeological interpretation	Certainty of interpretation	Occurrence Depth (m)	**Feature numbers**
6400	Ridge and furrow	Likely	0.3, 0.6	**5002, 5107**
6401	Plough marks	Likely	0.6	**5103**

Summary of Geophysical Survey Interpretations by Feature Period

On the following pages, the geophysical survey interpretations have been summarised by feature period.

Roman period features are summarised in Figure 60 and Table 20. It is noticeable that features **6100** and **6101** have been constructed across feature **6000** and have been interpreted as post-dating feature **6004**. Similarly features **6104**, **6105**, **6106** and **6107** occupy the likely position of the carriageway north of feature **6002** and have been interpreted as post-dating feature **6002**.

Feature **6004** has been interpreted as post-dating feature **6000** and to relate to the loop road through the west gate of the fort. Feature **6007** is also interpreted as relating to the loop road.

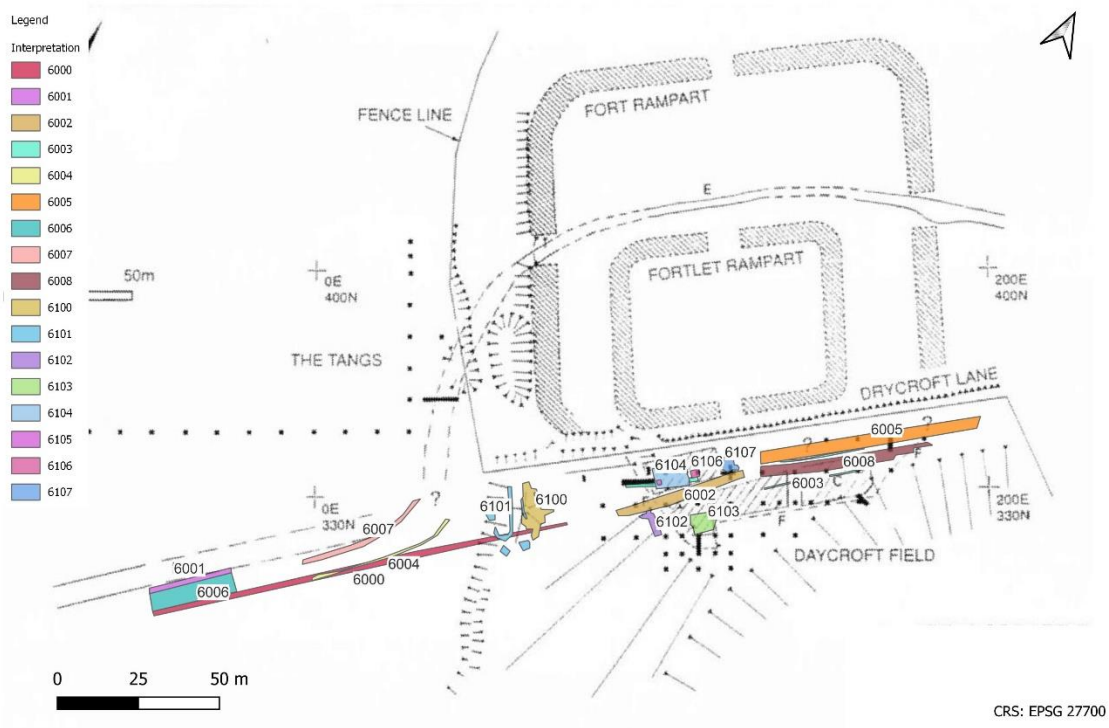

Figure 60 – Geophysical interpretation of Roman period features

Table 20 – Summary of geophysical interpretation of Roman period features

Composite feature number	Archaeological interpretation	Certainty of interpretation	Occurrence Depth (m) - GPR only	**Feature numbers**
6000	Road 712 south ditch	Likely	0.9, 1.2, 1.5, 1.8, 2.1	**5208, 5305, 5306, 5401, 5500, 5603**
6001	Road 712 north ditch	Probable	0.6	**5101**
6002	Road 712 south Ditch	Probable	0.6, 0.9, 1.2, 1.5, 2.1	**5212, 5311, 5408, 5508, 5605**
6003	Track ditch	Probable	0.9, 1.2	**5206, 5305**
6004	Loop road south ditch	Probable	0.9	**4002, 5209**
6005	Road carriageway	Possible	0.9, 1.2, 1.5, 1.8	**5211, 5312, 5409, 5506**
6006	Road carriageway	Possible		**3000**
6007	Loop road north ditch	Probable		**4000**
6008	Road south ditch	Probable	0.6, 0.9, 1.8	**5113, 5213, 5509**
6100	Building	Possible	0.6, 0.9	**5105, 5202**
6101	Building	Possible	2.1, 2.4	**5604, 5713**
6102	Building	Possible	0.6	**5114**
6103	Building	Possible	0.6	**5112**
6104	Building	Possible	0.6, 0.9, 1.2, 1.5	**5116, 5210, 5307, 5405**
6105	Feature inside **6104**	Possible	1.5	**5040**
6106	Building	Possible	1.8, 2.1, 2.4	**5048, 5054, 5060**
6107	Building	Possible	1.2	**5028**

Post-medieval features are shown in Figure 61 and Table 21 and pre-date the earliest detailed mapping of the area. Features **6200**, **6201** and **6202** overlie Roman period feature **6101**. Features **6203** and **6205** apparently cut into Roman period features. Quarrying features **6300** and **6301** also cut into earlier Roman features. Track **6009** is cut by features **6010**, **6200**, **6201**, **6202**, **6203**, and **6301** but appears to overlie and be later than the quarries, feature **6300**. Ridge and furrow feature **6400** and drains feature **6204** are at relatively shallow depth but are likely to have cut into Roman layers (Redhead, 1997).

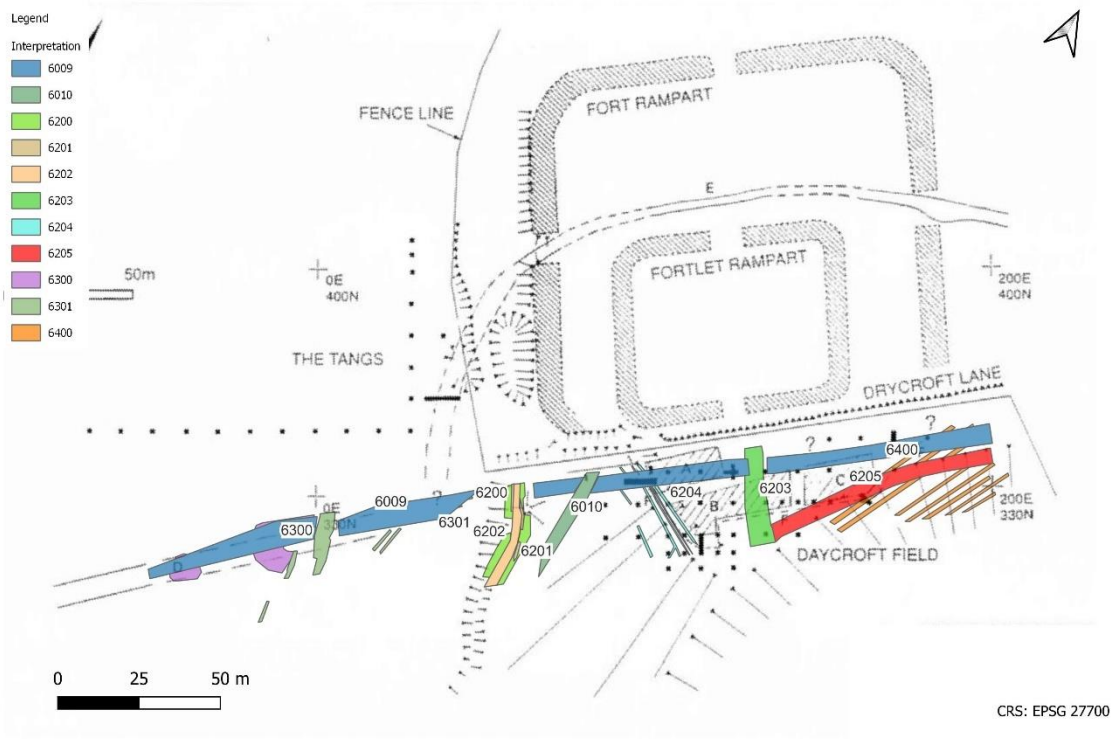

Figure 61 – Geophysical interpretation of Post-medieval period features

Table 21 – Summary of geophysical interpretation of Post-medieval period features

Composite feature number	Archaeological interpretation	Certainty of interpretation	Occurrence depth (m)	**Feature numbers**
6009	Track	Probable		**3001, 3004**
6010	Track	Probable		**3002**
6200	Drainage channel Cut	Likely	0.9	**3008, 5204**
6201	Drainage channel wall	Likely	0.6, 1.2, 1.5, 1.8	**4001, 5100, 5303, 5410, 5504**
6202	Drainage channel fill	Likely	0.3, 0.6, 0.9, 1.2, 1.5, 1.8	**5001, 5108, 5203, 5304, 5400, 5505**
6203	Infilled drainage channel	Possible	0.3, 0.6, 1.2, 1.5, 1.8, 2.1, 2.4	**3006, 5000, 5110, 5301, 5403, 5502, 5600, 5700**
6204	Drains	Probable	0.6, 0.9	**5102, 5205**
6205	Infilled drainage channel	Possible	1.2, 1.5, 1.8, 2.1, 2.4	**3005, 5310, 5406, 5507, 5606, 5704**
6300	Quarries	Probable	0.9, 1.2, 1.5, 1.8, 2.1, 2.4	**5200, 5309, 5404, 5503, 5602, 5702**
6301	Quarry tracks	Possible	0.6, 0.9	**5106, 5109, 5201**
6400	Ridge and furrow	Probable	0.3, 0.6	**5002, 5107**

Modern period features are shown in Figure 62 and Table 22 and post-date the earliest detailed mapping of the area. They include likely modern field drains (feature **6206**), plough marks (feature **6401)** and trenches from the 1995 and 1996 excavations (features **6500** and **6501**).

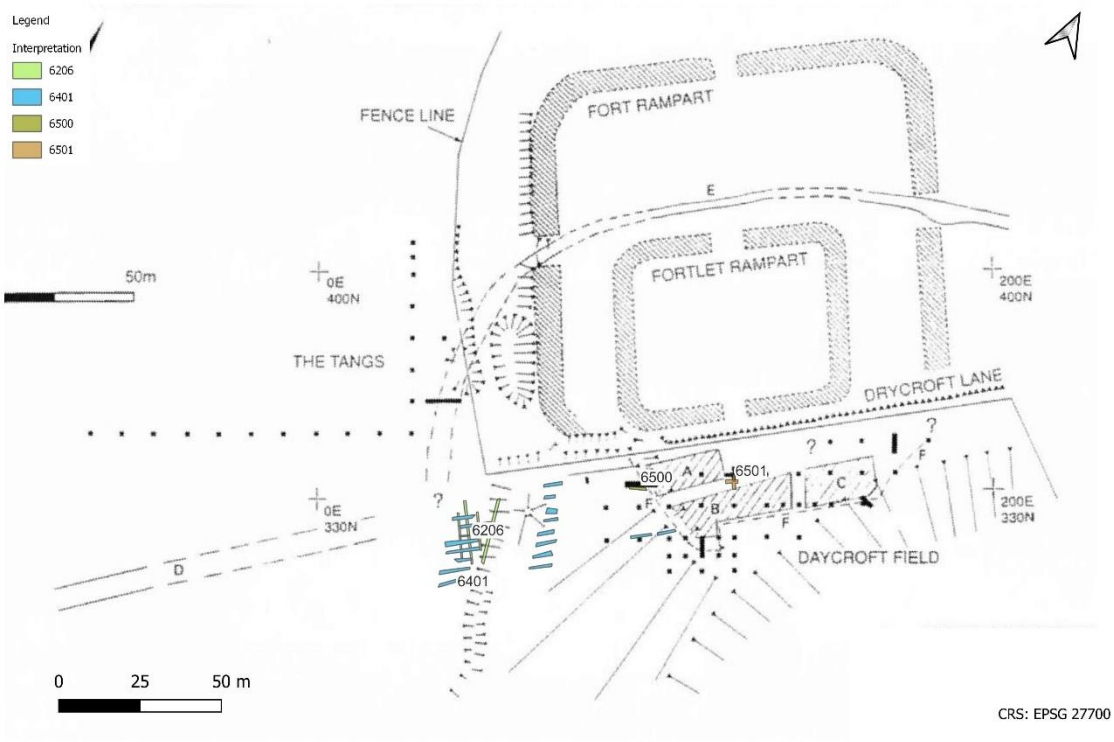

Figure 62 – Geophysical interpretation of Modern period features

Table 22 – Summary of geophysical interpretation of Modern period features

Composite feature number	Archaeological interpretation	Certainty of interpretation	Occurrence depth (m)	**Feature numbers**
6206	Drains	Likely	0.6	**5117**
6401	Plough marks	Likely	0.6	**5103**
6500	Trench 1 (1995)	Likely	0.6	**5115**
6501	Trench 3 (1996)	Likely	0.6, 0.9, 1.2	**5104, 5207, 5300**

Discussion and Conclusions

The reinterpretation of the Lidar data provided strong evidence of Road 712 at the western end of Daycroft Field and to the east of Castleshaw hamlet in the form of two parallel carriageways climbing towards the Standedge escarpment. A track was identified heading from near the south gate of Castleshaw fort to the edge of Waters Clough where a zigzag alignment is centred on an existing culvert. A former railway track is visible at the southwestern end of the field which have been interpreted as relating to reservoir construction.

The interpretation of the geophysical surveys has provided strong evidence of a series of features. The interpretations were informed by an examination of historical sources including mapping, the results of excavations carried out in 1994-6 by the Greater Manchester Archaeological Unit and the re-interpretation of Lidar data mentioned above.

The earth resistance survey provided good contrast between low and high resistance features. A low resistance feature has been interpreted as a later track immediately south of the fort. A problematic high resistance feature leading from near the south gate of the fort has been interpreted as a possible infilled drainage channel. Evidence for Road 712 was most clear at the western end of the survey. Other possible features identified immediately south of the fort and fortlet sites included several buildings, ditches, and tracks.

The gradiometer survey provided evidence of activity to the south of the fort but with insufficient detail to distinguish individual features. There were indications of the junction of a loop road into the west gate of the fort with Road 712. There was also evidence of a drainage channel heading away from the southwest corner of the fort towards Waters Clough.

The ground penetrating radar survey provided evidence of many features and gave approximate information on the depth of the features. At levels around 0.6 m deep, ploughing features and field drains have been interpreted. Near to the southwestern corner of the fort, a drainage channel has cut through the Roman layers and ties in with a ditch visible on Lidar. There is evidence of quarrying at the western end of the survey which appears to have slighted Road 712, although its southern ditch appears to have survived as far east as the drainage channel described above. There is also evidence of buildings around

and possibly underlying the drainage channel. The problematic feature heading southwards from the south gate of the fort (also seen in the resistivity survey) appears to have a depth more than 3 m. There is evidence of buildings on and alongside the line of Road 712 south of the fort which have been interpreted as belonging to a second phase of development after the original road alignment was diverted through the fort via the loop road described above.

The GPR survey also showed a feature immediately south of the south gate of the fort and this was identified as Trench 3 of the 1996 excavations (Redhead, 1997). This gave confidence of the positioning of the 1994-6 excavations relative to the features identified by the geophysical surveys of this project. It also allowed the GPR survey depths to be calibrated. The survey depths obtained from the processing of GPR data should still be treated with caution as they are based on a single value of the dielectric constant which will vary across the site and be dependent upon local ground conditions.

There was a strong corelation between the earth resistance and GPR surveys. The gradiometer survey showed little detail but supported the earth resistance and GPR surveys regarding occupation activity in the area immediately south of the fort.

The Lidar data to the southwest of Castleshaw fort show continuity of evidence of Road 712 with the earth resistance and GPR survey data. The Lidar data to the northeast of the fort show potentially two parallel carriageways of Road 712 climbing up to the Standedge escarpment. The parallel alignment passes through an isolated field northeast of Castleshaw House which would be particularly suitable for investigation and may clarify the relationship of the two carriageways.

This geophysical surveys provide evidence to support previous interpretations that Road 712 originally bypassed the fort to the south. The positioning of the fort apparently allowed sufficient room for a road to be built on the sandstone spur. The fort is aligned on a similar axis to the road, and this suggests that the fort and road may have been conceived together. The fort could then have been a base for the construction of the road, or the fort and road may have been part of a single construction operation.

The evidence of buildings at depth to the south of the fort revealed by the GPR survey is of particular interest. The relationship of features **6100** and **6101** to Road 712 and the drainage

channel would provide valuable evidence of phasing as the building appears to have been slighted by Road 712. The existence of feature **6101** at depth suggests a subterranean element of the building and it is tentatively identified as part of a bath complex with hypocaust. It is possible that feature **6100** may also be part of the bath complex but without hypocaust and thus founded at a higher level. It is worth noting that the exploration of the other sides of the fort has not revealed a bath house and that bath houses have been recorded at contemporary nearby forts at Slack (Dodd and Woodward, 1922), Manchester (Dennison, 1911), Melandra (Wilson et al., 1974, p. 420) (Goodburn et al., 1976, pp. 322-3) (Frere et al., 1977, pp. 387-8) (Goodburn et al., 1978, p. 432) (Goodburn et al., 1979, p. 293) and Wigan (Miller and Zant, 2008). Feature **6106** was also found at depth and appears to have had a subterranean element. This has been tentatively interpreted as a well. Trial trenching of features **6100**, **6101** and **6106** would be necessary to assess the validity of the interpretations.

There are two significant ditch features within Daycroft Field, **2101** and **2103**, running down the slope to the south of the fort. Drycroft Lane is recorded in the 18th century as acting as a linear reservoir for part of the year to supply water to power Waters Clough mill. The western feature aligns with an apparent drainage channel, feature **6202,** channelling water from the linear reservoir to the mill. The second feature appears to coincide with feature **6203** which was found to be around 4 m deep on the GPR survey and is of unknown purpose. It aligns approximately with the *via principalis* of the fort and fortlet and a zigzag track where the slope steepens adjacent to Waters Clough. The zigzag leads to a stone culvert on Waters Clough of unknown date.

Investigation of the projected crossing of Waters Clough on the line of Road 712 further down the valley from the fort would be of particular interest, as timber structural elements of a bridge may have been preserved.

Recommendations

The areas of further study that are recommended by this project are listed below.

- Trial trenching of features **6100**, **6101** and **6106** to assess their tentative interpretations as buildings and to confirm their relationship with Road 712.
- Trial trenching south of the fort to assess the interpretations of the ditches and carriageway of Road 712 and determine the nature of feature **6203** heading south of the south gate of the fort.
- Excavations in the isolated field east of Castleshaw hamlet to assess the relationship of the two carriageways of Road 712 leading to the Standedge escarpment.
- Archaeological investigation of the river crossing of Waters Clough by Road 712 southwest of Castleshaw fort.

Publicity, Confidentiality and Copyright

Publicity will be handled by the Friends of Castleshaw Roman Fort.

The Friends of Castleshaw Roman Forts will retain the copyright of all documentary and photographic material under the Copyright, Design and Patent Act (1988).

Statement of Indemnity

All statements and opinions contained within this report arising from the works undertaken are offered in good faith and compiled according to professional standards. No responsibility can be accepted by the authors of the report for any errors of fact or opinion resulting from data supplied by any third party, or for loss or other consequences arising from decisions or actions made upon the basis of facts or opinions expressed in the report, however such facts and opinions may have been derived.

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Appendix

Processing of Earth Resistance Data with Snuffler Version 1.32 Software

For the data processing with the Snuffler software, a map file was created for the data collected. The map file contained the relative positions of the survey grids. A view of the raw data was created for the map file by using the spawn main view command. The view was minimally processed.

Processing of Gradiometer Data with Snuffler Version 1.32 Software

For the data processing with the Snuffler software, a map file was created for the data collected. The map file contained the relative positions of the survey grids. A view of the raw data was created for the map file by using the spawn main view command. The view was then processed using the following filters: -

- Remove spikes using a threshold of 7.9 nT/m and a flattening effect of “normal”.
- Destripe using the method “multi-zero main line”. This was carried out for the data collected on each day due to differences in calibration of the gradiometer sensors.
- Interpolation in the horizontal direction – i.e. between traverses.

A greyscale linear display was produced using 98% of readings with positive anomalies shown as dark and negative anomalies as light (Figure 63).

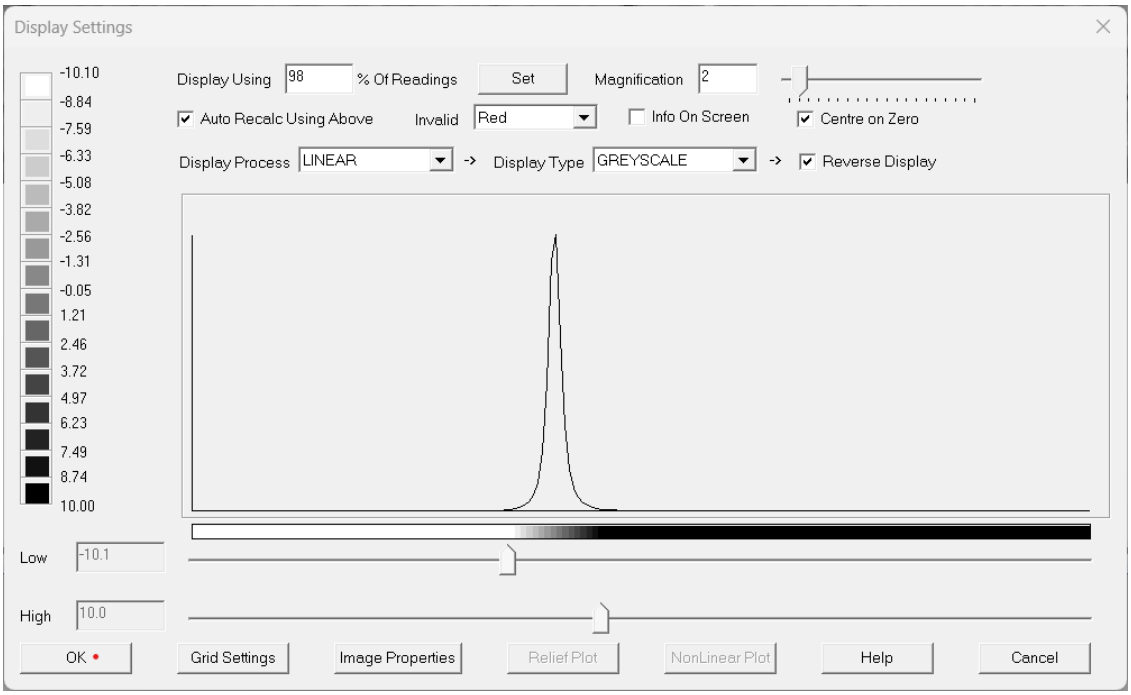

Figure 63 – Snuffler gradiometer image display settings

Processing of GPR Data with Geolitix Software on Cloud-based Platform

The following processes were carried out on the GPR profiles generated from the 0.5 m traverses: -

- A time zero correction using the method “find positive peak” was applied to allow for the transmitter being slightly above ground level. No back up samples were used and the “trace by trace” option was not used.
- A background subtraction was carried using the method “remove average” and using the maximum number of traces (99) from a time of 0 ns.
- A manual gain correction was applied based on a pre-determined curve of 25 dB at 0 ns, 50 dB at 15 ns, 60 dB at 20 ns, 705 dB at greater than 40 ns.
- A frequency filter was applied using the method “band pass” with a lower band of 313 MHz and an upper band of 1521 MHz and a filter order of 24.
- A migration was carried on using the minimum number of traces (five) and the project velocity.

These parameters were termed processing group 1 (500) and were used to generate profiles for inspection.

A further process, a Hilbert Transformation, was added to processing group 1 to create processing group 2 (500) and the profiles were processed again.

Horizontal slices were then produced using the following parameters.

- A greyscale colour scheme
- The “Source” was the profiles generated with processing group 2 (500)
- Griding method was inverse distance weighted with a power parameter of 1.5
- Grid cell size was 0.1 m
- Search radius was 0.6 m
- First depth was 0 m
- Depth increment was 0.1 m
- Maximum depth was 6 m
- Slice thickness was 0.15 m

Post processing of the slices was then carried out using interpolation process and an upscaling factor of 3.

The process was then repeated for the GPR slices generated from the survey which used 0.25 m traverses. The only different parameters used were as follows: -

Processing Group 1 (250)

- A manual gain correction was applied based on a pre-determined curve of 25 dB at 0 ns, 42 dB at 12 ns, 50 dB at 20 ns, 70 dB at greater than or equal to 40 ns.
- A frequency filter was applied using the method “band pass” with a lower band of 376 MHz and an upper band of 2457 MHz and a filter order of 20.

Processing group 2 (250) was created by adding the Hilbert Transformation to Processing Group 1 (250)

Horizontal slices were then produced using the following parameters.

- A greyscale colour scheme
- Source was the profiles generated with processing group 2 (250)
- Griding method was inverse distance weighted with a power parameter of 0.4
- Grid cell size was 0.1 m
- Search radius was 0.3 m
- First depth was 0 m
- Depth increment was 0.1 m
- Maximum depth was 6 m
- Slice thickness was 0.15 m

Historic England

Historic England Geophysical Survey Summary Questionnaire

Survey Details

Name of Site: CASTLESHAW ROMAN FORTS
County: Metropolitan Borough of Oldham

NGR Grid Reference (Centre of survey to nearest 100m): 399900 409600

Start Date: 20th May 2023 **End Date: 30th July 2023**

Geology at site:
There are no drift deposits at the site.
There is Shale Grit sandstone bedrock at the site.

Known archaeological Sites/Monuments covered by the survey:
Scheduled Monument No. 1017837

Archaeological Sites/Monument types detected by survey

Roman road and roadside ditches
Roman vicus buildings including possible bath house?
Roman tracks within vicus
Infilled drainage channels – Post-medieval?
Ridge and furrow ploughing – Post-medieval
Quarrying - Post-medieval?
Land drains – Post-medieval? and modern?

Surveyors:
Resistivity: Phil Barrett
Magnetometer and Ground Penetrating Radar: Tim Jeffery as part of an MA dissertation for the Department of Archaeology, University of Sheffield

Name of Client, if any:
Friends of Castleshaw Roman Forts

Purpose of Survey:
To determine the presence or otherwise of the Roman road termed Margary 712 in Daycroft Field to the south of Castleshaw Roman Forts.

Location of:

a) **Primary archive, i.e. raw data, electronic archive etc:**
Friends of Castleshaw Roman Forts members area

b) **Full Report:**
Friends of Castleshaw Roman Forts members area

Historic England

Technical Details - 1

Type of Survey:
Resistivity (Earth Resistance)

Area Surveyed:
0.8 hectares

Traverse Separation, if regular:
1 m

Reading/Sample Interval:
1 m

Type, Make and model of Instrumentation:
Resistance Meter, Frobisher TAR-3

Probe configuration:
Twin electrode

Probe Spacing:
Twin mobile probes at 0.5 m spacing, twin remote probes kept 15 m to 20 m away from the average grid position of the mobile probes throughout the survey

Land use at the time of the survey:
Grassland – Pasture

Technical Details - 2

Type of Survey:
Magnetometer (Gradiometer)

Area Surveyed, if applicable:
0.8 hectares

Traverse Separation, if regular:
1 m (in overall transverse direction)

Reading/Sample Interval:
0.25 m

Type, Make and model of Instrumentation:
Dual gradiometer Bartington Grad601-2

Land use at the time of the survey:
Grassland – Pasture

Historic England

Technical Details - 3

Type of Survey:
Ground Penetrating Radar (GPR)

Area Surveyed, if applicable:
0.8 hectares

Traverse Separation, if regular:
0.5 m (in overall transverse direction) over 0.8 hectare area
0.25 m (in overall longitudinal direction) over 0.1 hectare area outside the south gate of Castleshaw Forts

Reading/Sample Interval:
0.04 m

Type, Make and model of Instrumentation:
Pushcart, Impulse Radar, Crossover 1760 dual frequency (170 MHz and 600 MHz)

Land use at the time of the survey:
Grassland – Pasture

Additional Remarks:

All surveys were related to survey points set out using GNSS equipment by taping between survey points. GNSS data on GPR pushcart position was only partially successful and was not used.

An additional partial GPR survey was carried out on 9th June 2023 to fill in blank profiles from the GPR survey carried out between 26th and 29th May 2023.