A geophysical survey of the Purton Ships Graveyard:

The south west quadrant

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A paper submitted in fulfilment of the requirements of the Joan du Plat Taylor Awards. This research programme was carried out by the Friends of Purton in collaboration with the Nautical Archaeology Society.

November 2010

AKNOWLEDGEMENTS

The Friends of Purton would like to thank all who took part in the project with specific thanks being made to Mark Betty Edwards and the Nautical Archaeology Society for their continued help and guidance, not only with this project but with the various projects that we have had the great pleasure to work on over many years.

We would also like thank the panel of the Joan du Plat Taylor award for providing the all important funds and thereby making this project a viable proposition.

Our sincere thanks are further extended to the Claire Graham and her enthusiastic team at Stratascan Limited who, not only battled the terrain and elements to source the base data, but who agreed to match fund the project and without who's support we would never have achieved as much as we did, for so little financial reward.

My final thanks go to the Friends of Purton, who year on year have rallied to the cause of this rural backwater, with the steely determination to promote our maritime heritage..

Paul Barnett
Chairman
Friends of Purton
25th November 2010

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Document Title:	A geophysical survey of the Purton Ships Graveyard: The south west quadrant.
Author:	Louis Paul Barnett, M.Sc. Chairman, Friends of Purton.
In collaboration:	Stratascan Limited.
Date of report	November 2010.
Techniques:	Detailed magnetic survey (gradiometry)
National Grid Ref:	SO 683 040.
Stratascan Field Team:	Richard Fleming & Allen Wright BA Simon Stowe BSc. Claire Graham BA Peter Barker C.Eng MICE MCIWEM MIFA
Part funded by	The Joan du Plat Taylor Award 2010

1: INTRODUCTION

1:1 Initial summary of results

Conducted as part of an ongoing Friends of Purton phase three programme of research to determine the extent of the Purton Ships Graveyard, Gloucestershire, the following gradiometer survey was conducted to ground truth an area made up of approximately 1.55 hectares of marine alluvial, moraine deposits and foreshore vegetation that runs perpendicular to the River Severn and the Sharpness to Gloucester Canal at Purton, Gloucestershire. Early indications confirm the effective application of the dual sensor *Grad601-2 Magnetic Gradiometer* to provide good coverage and uniform ground penetration. Furthermore, initial findings support the successful relocation of five previously unknown anomalies, three of which appear to be consistent with containing large quantities of ferrous material, whilst two, conform to a less dense material, typically wood. [1]

1:2 Survey aim

Following a successful grant application by Friends to the Nautical Archaeology Societies - Joan du Plat Taylor Awards, funds were secured and Stratascan Ltd have successfully conducted a geophysical survey of the south west quadrant of the site.

The principal aim of the survey was to locate, position and record all surviving archaeological remains within the south west quadrant of the Purton Ship Graveyard.

1:3 Survey objectives

To achieve this aim, the study explored the following key themed objectives:

i. Establish the extent and spread of buried archeological remains,
ii. Determine and evaluate possible vessel construction material,
iii. Compare and contrast known historical data with located anomalies,
iv. Evaluate vessel depth and heading,
v. Evaluate the potential for future archeologically studies.

2: HISTORIAL REVEIW

2:1 Site location and designation

The Purton Ships Graveyard is bounded to the west the by the River Severn and to the east by the Gloucester to Sharpness Ship Canal. The site extends northwards to the Purton Lower Bridge (NGR: SO 687045) and southwards to Sharpness Docks (NGR: SO 670 031), [2] a distance of *c.* 2.3km, encompassing an area of *c*.9.2ha of mud, sand flats and mature salt marsh. [3] The site is designated as a Site of Special Scientific Interest (SSSI) (Natural England has issued blanket consent, dependant upon season, for the proposed programme of works to take place), a wetland of international importance (RAMSAR Site) and a Special Protection Area (SPA) for birds. It is a European Marine Site and forms part of a network of wildlife site across Europe known as 'Natura 2000'. The Severn estuary is also being considered as a Special Area of Conservation (SAC) (ASERA 2007). [4]

2:2 Geology and soils

The underlying geology is Lower Old Red Sandstone (British Geological Survey South Sheet, Fourth Edition Solid, 2001). There is no drift geology recorded at the site. The overlying soils are known as Hodnet which are typical stagnogleyic argillic brown earths. These consist of reddish fine coarse loamy soils with slowly permeable sub-soils and slight seasonal water-logging. [3]

2:3 Early site history

The night of 23rd December 1909 saw remedial works initiated by *Mr A J Cullis*, the then Chief Engineer of the Berkeley, Gloucester and Birmingham Canal, following a partial collapse and a mass rotational slump of a sixty meter section of unprotected river foreshore and adjacent earthen canal bank. Subsequently and by way of a temporary solution, *Mr Cullis* procured a small fleet of semi redundant wooden barges which were duly taken into the river and intentionally run aground to plug the breach and shore up the eroding bank. Seen as a complete success the Purton Ships Graveyard can now be effectively used as a economic barometer, as its development, parallels the various periods of Gloucestershire's maritime boom and bust, namely the abandonment of the redundant *Rice Brothers* fleet in 1951, the 1956 & 1963 Bristol

additions which catalogue the changing fortunes of Lydney Dock, the disposal of *Fred Ashmeads* obsolete *St. Annes Board Mills* fleet and the nationalised British Waterways steel lighter fleet in 1970s to protect the Sharpness reaches. [5]

2:4 Early site recording

The vessels within the Purton Ships Graveyard have been surveyed and recorded by a variety of authors. Theses include:

Graham Farr 1935 - photographic survey, [6}

Basil Greenhill 1940 - photographic survey, [7]

Arthur Woodward 1951 – diary and photographic survey, [8]

David MacGregor 1952 and 1964, schematic and photographic survey, [9]

Robert Schopland 1958 - photographic survey, [10]

Peter Stuckey 1961 - photographic survey, [11]

David Wheeler 1965 - schematic and photographic survey, [12]

Elizabeth Wood *et. al.* - 1971 - schematic and photographic survey, [13]

Jim Crissup 1986 - schematic and photographic survey, [14]

Colin Green 1996 - schematic survey, [15]

Anthony Parker *et. al.* - 1996 schematic survey, [16]

Louis Paul Barnett 1999 - schematic and photographic survey. [17]

2:5 Recent site recording

The site has more recently been surveyed and recorded in 2004 by Barnett who purports that there are the remains of some 81 vessels in situ. Subsequent historical research has established the identity of seventy-seven of the beached vessels. [18]

2006 saw Small and Stoertz analyse the finding of the English Heritage funded *Forest of Dean National Mapping Programme* that included an aerial survey of the northern extremes of the Purton site. In doing so, the project duly complemented the findings of the National Monument Records database (AMIE). [19]

Early 2007, saw the publication of the site guide, *Fore and Aft: The Story of the Purton Ships Graveyard,* [5] which outlined the history and development of the site and aided the general public's appreciation of the remaining artefacts.

This new found appreciation further lead to the formation of the Friends of Purton (FoP) in November 2008, whose core objectives are:

> *To protect and secure the undefined site and abandoned vessels lying within it at Purton, Gloucestershire,*
>
> *To foster general, professional, historic, archaeological and scientific interest and promote an understanding of this unique resource and facilitate continued investigation and research thereof.*
>
> *The Friends of Purton Constitution [20]*

More latterly the findings of FoP have been summarised in a joint 2008 report by the Nautical Archaeology Society, FoP and Wessex Archaeology. [21] December of this year also saw the construction and continued management of the Friends dedicated website www.friendsofpurton.org.uk.

Spring 2009, saw the completion of a topographic survey by Mr Paul Wilson of Online Construction Management in collaboration and on behalf of FoP. In doing so, the vessels remains have now been comprehensively recorded to within 30mm. [22] This year also saw the completion of *Rapid Coastal Zone Assessment, Phase One Report,* [23] and Catchpole and Chadwick's *Phase 2a Project Design.* [24] This has resulted in a joint undertaking by Gloucestershire County Council and FoP to compile the *Stage 2a Pilot Fieldwork Phase Report*, which is currently in the final stages of completion and due in 2010. [18] September saw the Friends embark on their most ambitious recording operation to date, in the limited excavation of the Kennet barge *Harriett.* [25]

2010 proved to be a pivotal year with the Friends completing a comprehensive series of 36 *Phase One Vessel Reports* and a comprehensive *Site Damage Findings Report.* [26] More recently, various vessels have been surveyed by Birmingham University using a *Leica HDS6000*, a phased base terrestrial laser scanner, to record the surface of several hulks to an operational range of 0.2 to c.50m. [27] Finally June 2010 saw

the remains of the Kennet built canal boat *Harriett*, being recognised of national importance, through its designation as a Scheduled Monument. [28} Finally August 2010 saw the site being formally registered in the ownership of British Waterways.

Early indications would suggest that 2011 is shaping up to be most interesting times both at Purton and within a wider archaeological context. The primary reason for this is the eagerly awaited findings of the University College, London, who are presently engaged in a national review of all maritime assemblages. The findings are due out in March 2011.

3: METHODOLOGY

3:1 Survey methods

A detailed magnetic survey (gradiometry) which was both man-hour efficient and proved an effective method for locating buried archaeological anomalies.

3:2 Fieldwork conditions

Fieldwork was carried out during September 2010, following an extended of period of fine, dry weather. This resulted in consolidated clay conditions under foot, predominantly covered by dense mature foreshore sedge grasses and narrow leaf salt marsh vegetation to 60cm height. Grids 10, 11. and 12 at the site southern extremes were heavily populated with mature water sedge and reeds to 2.5m height. As such these areas were inaccessible and thus excluded from the survey.

3:3 Grid locations

The location of the survey grids were plotted (see figure 4), together with the referencing information. Grids were set out using a *Leica Smart Rover RTK GPS*. (Real-time Kinematic Global Positioning System). This technology was chosen as it can efficiently locate a point on the ground to a far greater accuracy than a standard GPS unit, which is prone to errors created by satellite orbit errors, clock errors and atmospheric interference, resulting in a reduced accuracy of 5m - 10m. An RTK system uses a single base station receiver and a number of mobile units. The base

station re-broadcasts the phase of the carrier it measured, and the mobile units compare their own phase measurements with those they received from the base station. A *SmartNet RTK GP*S uses Ordnance Survey's network of over 100 fixed base stations to give an accuracy of around 0.01m.

3:4 Survey equipment

The magnetic survey was conducted using a dual sensor *Grad601-2 Magnetic Gradiometer* manufactured by Bartington Instruments Ltd. The instrument consists of two fluxgates very accurately aligned to nullify the effects of the Earth's magnetic field. Readings relate to the difference in localised magnetic anomalies compared with the general magnetic background. *The Grad601-2* consists of two high stability fluxgate gradiometers suspended on a single frame. Each gradiometer has a 1m separation between the sensing elements so enhancing the response to weak anomalies. Although the changes in the magnetic field resulting from differing features in the soil are usually weak, changes as small as 0.2 nanoTesla (nT) in an overall field strength of 48,000nT, can be accurately detected using an appropriate instrument.

The mapping of the anomaly in a systematic manner will allow an estimate of the type of material present beneath the surface. Strong magnetic anomalies will be generated by buried iron-based objects or by kilns or hearths. More subtle anomalies such as pits and ditches can be seen if they contain more humic material which is normally rich in magnetic iron oxides when compared with the subsoil. To illustrate this point, the cutting and subsequent silting or backfilling of a ditch may result in a larger volume of weakly magnetic material being accumulated in the trench compared to the undisturbed subsoil. A weak magnetic anomaly should therefore appear in plan along the line of the ditch.

3:5 Sampling interval

Readings were taken at 0.25m centres following predetermined traverses set at 1m distances apart. This equates to 3600 sampling points in a full 30m x 30m grid.

3:6 Depth of scan and resolution

The *Grad 601* has a typical depth of penetration of 0.5m to 1.0m. This would be increased if strongly magnetic objects have been buried in the site. The collection of data at 0.5m centres provides an optimum methodology for the task balancing cost and time with resolution.

3:7 Data capture

The readings were logged consecutively into the data logger and were routinely down-loaded to a portable computer whilst on site. This data set was duly transferred to dedicated office computers/ software for processing and presentation.

3:8 Processing

Processing was performed using specialist software known as *Geoplot 3.* This can emphasise various aspects contained within the data but which are often not easily seen in the raw data. Basic processing of the magnetic data involves 'flattening' the background levels with respect to adjacent traverses and adjacent grids. 'Despiking' is also performed to remove the anomalies resulting from small iron objects often found on agricultural land. Once the basic processing has flattened the background it is then possible to carry out further processing which may include low pass filtering to reduce 'noise' in the data and hence emphasise the archaeological or man-made anomalies.

The following schedule shows the basic processing carried out on all processed gradiometer data used in this report:

> ***Despike*****:** (useful for display and allows further processing functions to be carried out more effectively by removing extreme data values),
> *Geoplot parameters:* X radius = 1, y radius = 1, threshold = 3 std. dev.
> Spike replacement = mean.
>
> ***Zero mean traverse:*** (sets the background means of each traverse within a grid to zero and is useful for removing striping effects),
> *Geoplot parameters:* Least mean square fit = off.

3:9 Presentation of results and interpretation

The presentation of the data for each site included a print-out of the raw data as greyscale and colour plots showing the extreme magnetic values, together with a greyscale plot of the processed data. Magnetic anomalies were identified and plotted onto the *'Abstraction and Interpretation of Anomalies*' drawing for the site.

4: RESULTS

4:1 Area one - Marshfield

Area one: Marshfield, was the largest of the three areas surveyed and was considered the primary region of investigation. Two very high amplitude responses are observed in the north and centre of this area. These responses were at maximum amplitude of +/-3000nT and were caused by buried metallic remains. Furthermore and to the south of the site, two areas of positive response were identified. These anomalies were at maximum amplitude of 32nT and may be related to buried remains of timber vessels or structures. Further isolated moderate to high amplitude responses were observed throughout this area and may be as a result of scattered metallic debris associated with the archaeological deposits. Weak positive and negative anomalies were observed across the area and are likely to be of geological/pedological origin.

4:2 Area two - *Mary Ann*: validation of results

Area two: *Mary Ann*, was a smaller area selected within the region of a known interred vessel and within the fingerprint of a previously recovered concrete lighter *Ferrous Concrete Barge 52*. This objective of this survey was to:

Validate instrument and processing operations,
Locate, position, and correlate the quantities of remaining vessel timbers,
Determine the depth and dimensions of the remaining timbers.

The gradiometer survey identified a large area of strong magnetic variation which is consistent with buried metallic remains. This suggests that there are still buried remains of the vessel present.

4:3 Area three – The dowsing group triangulation

Area three: The dowsing group triangulation covered a very small area to the south west of Area one which had previously been walked by Slimbridge Dowsing Group who in turn had presented a report [29] to suggest the location of several buried vessels within the region (see figure 16). The detailed magnetic survey, did not present any further evidence to support that any buried remains were to be found within the region.

Plate 1 Peter Gibson Slimbridge Dowsing Group

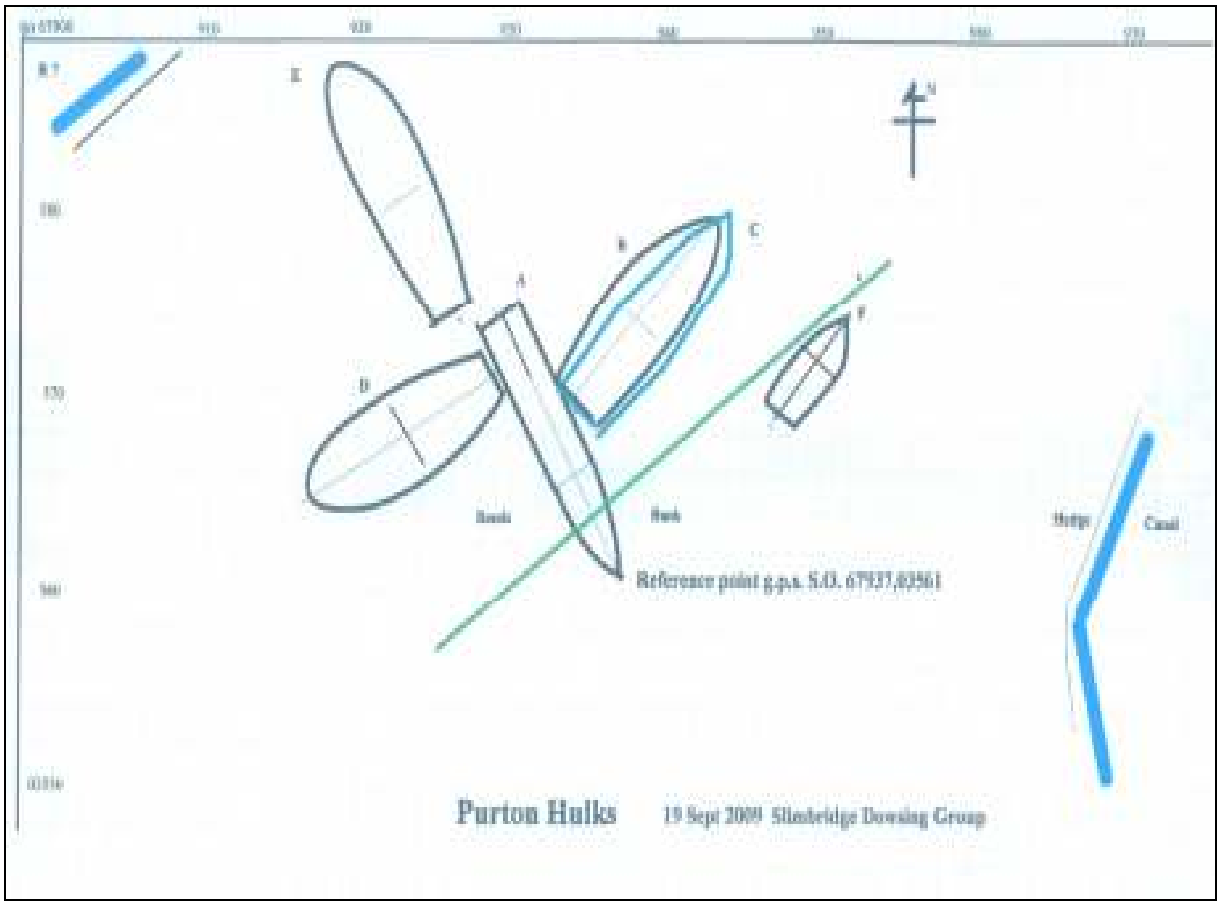

Figure 1 The findings of the Slimbridge Dowsing Group.

5: CONCLUSION

5:1 Establish the extent and spread of buried archeological remains

When on considers historically evidence pertaining to the abandonment of vessels with this section of the site, one quickly establishes that there is significant evidence to support the beaching of additional and as yet unidentified vessels on the foreshore to the north of the railway bridge. Indeed, Graham Farr goes further in his book Chepstow Ships by stating this is not a recent occurrence, as he advises that the site is the resting place of the 1780 built Severn trow *Sally* which was purported to have been beached to form a breakwater as early as 1875. [30] This project has therefore significantly added to our understanding by ground-truthing the region and thereby stripping back the decades of inundation and spoil disposal, to unearth the location of at least five previously unknown anomalies. Furthermore the survey can be said to have preformed adequately well in providing validation of the both Areas two and three.

5:2 Determine and evaluate possible vessel construction material,

It would of course be fool hardy to attempt to offer firm identification of vessel remains at this early stage, however what is certain is that the survey has provided evidence relating to the extent and spread of the buried archeological, whilst the technology would suggest that we are potentially looking at five previously uncharted anomalies containing both ferrous and timber materials.

5:3 Compare and contrast known historical data with located anomalies,

Going further and upon historical review, various sources exists that support the location of at least five vessels within the survey region. First and foremost, held within the British Waterways deposit at Gloucestershire Archives, is document *D2460 4/7/1/52*, which dates to November 1909. This consists of a location plan and four cross sections of the foreshore which shows the locations of two timber vessels pointing up the foreshore, with their sterns near to the low water level, one apparently in line with the Black Cottage and the other in line with the end of the sea wall. [31] It is at present impossible to tie in these vessels with this study, however one is

confident that they had been beached as stated and therefore will remain, albeit in a vastly corroded state, within the surveyed quadrant. What should be noted however, is that these vessels may be beyond the penetration capacity of the *Grad 601* and may indeed lie in the lower strata of the dowsed zone at Grid 23*, who is to say without excavation?*

Regardless of this, further tangible evidence has been presented by FoP member David Wheeler, who has recorded the site between 1958 and 1965. [12] At this time, David produced an unmeasured sketch plan which located five timber vessels and *FCB51* in the survey area.

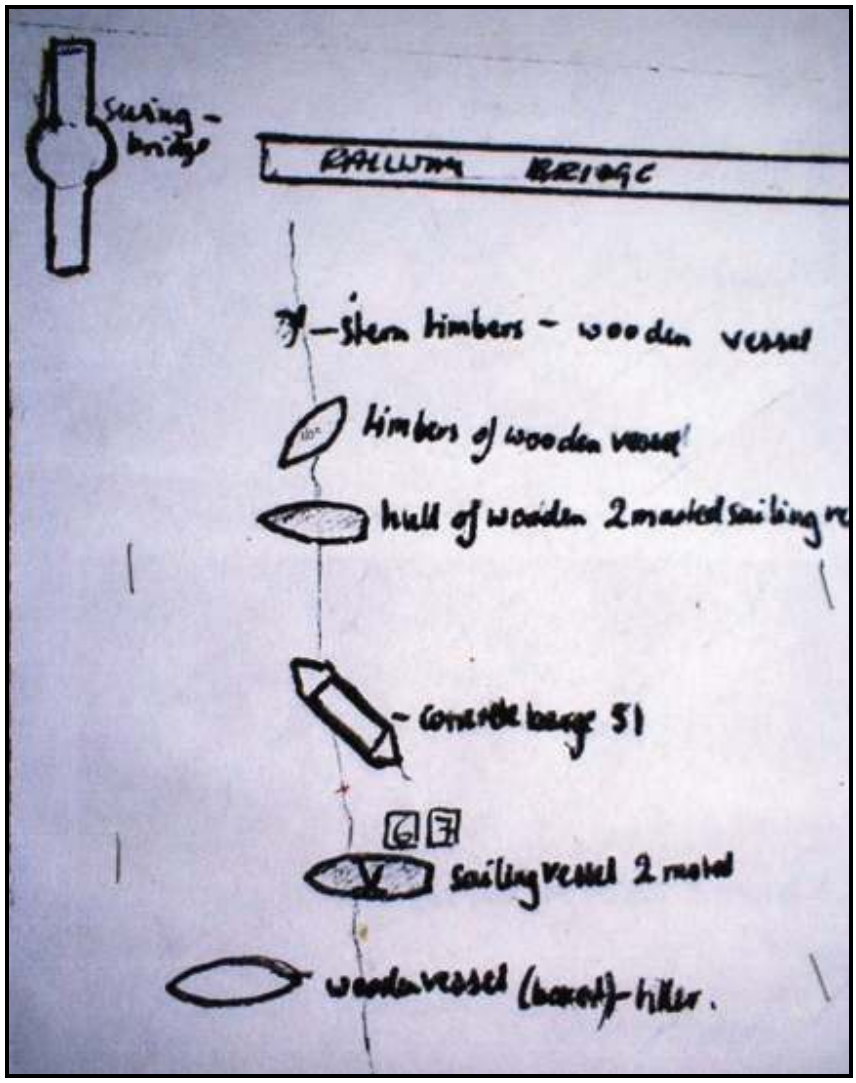

Plate 2. David Wheeler's 1965 schematic drawing

Upon considering this available evidence, I would like to offer the following interpretation and possible vessel identification running north to south.

Barge Abbey (FoP 37), a vessel referred to by Wheeler as 'wooden vessel (boxed) tiller [12] and marked by MacGregor as No 3 'Barge hidden in rushes' [9] and also seen in the National Monuments held aerial photograph of 26th August 1945 (RAF/106G/UK/733 frame no 3048) alongside what is considered a stone groin. [32]

Selina Jane (FoP 38), identified as 'vessel V – sailing vessel 2 masted [12] and marked by MacGregor as No 2 'Ex – Ketch? Stern Missing' [9] also seen in the National Monuments held aerial photograph of 26th August 1945 (RAF/106G/UK/733 frame no 3048) alongside what is considered a stone groin. [32]

FCB 51 (FoP 39), identified by Wheeler as *Ferrous Concrete Barge 51* [12], which is understood not to have been present during Macgregor's visit of October 1952. [9]

Unknown (FoP 40), Marked in 1961 by Wheeler as Hull of wooden 2 masted sailing vessel showing a square sterned vessel bow to shore. [12] Not recorded by MacGregor. [9] Available evidence suggests that this may be the *Excelsior* which Farr purported, was beached in the early 1950s. [6]

Unknown (FoP 41), Marked by Wheeler as 'timbers of wooden vessel' showing a two bowed vessel lying east west. [12] Upon comparison and alignment of both schematics this may be the same vessel marked No 1 by MacGregor as 'Unknown – covered at high water showing the pointed bows of a vessel and again in original field notes as "½ sunken K" showing bow to shore. [9] Parker in 1998, apparently looked for this vessel and indicates it as 'not visible 1997 (approx. position)'. [16]

Unknown (FoP 42), Marked by Wheeler as 'stern timbers – wooden vessel showing stern and rudder bow to shore'. [12]

The location of vessel *Mary* (FoP 43), now destroyed by fire and interred, is not marked on either Wheeler's or MacGregor's plans but her location has been corroborated via local knowledge and images following her abandonment *c*. late 40s early 50s. [8]

5:4 Evaluate vessel depth and heading,

This survey has further provided a clear insight relating to the heading and depth of the archaeology and can therefore aid a geomorphological perspective relating to sediment deposition and historical foreshore development and tidal stream. Upon review, one is further reminded of the foreshore's development and bank encroachment of the constantly changing River Severn which has now apparently left the large river going craft buried some 200m from the present days water's edge. This fact is confirmed by *Beechley,* who, in 1849, outlined concerns regarding a channel that had formed only 230ft from the canal bank behind the Black Cottage and the end of the sea wall at that time [31] It is of course immensely difficult to correlate these vessels to those shown in the 1909-10 documents especially when one considers that thousands of tonnes of dredging spoil were purported to have been deposited in the region during the 1940. Evidence to support this can be seen in the following post card of the area during that time which shows the build up of dredging material to the north of the railway bridge whilst *Selina Jane* is clearly visible in the middle ground.

Plate 3. The site during the 1940s courtesy of Pat Greatrix

5:5 Evaluate the potential for future archeologically studies

This project has clearly highlighted the need to conduct further research in order to determine the full extent of the buried archaeology within the constantly shifting sediments of the Purton Ships Graveyard. As a result and due to geological resistively, it would be preferable to conduct a series of ground penetrating radar surveys with specific reference to the five areas of high magnetic returns and thus obtain greater clarification as to the nature of the archaeology. Once achieved, recent successful trials of a probe survey would prove invaluable as they have in the past have shown that the method it is capable of gathering rudimentary information pertaining to no intrusive survey whilst excavation of course remains the only true way of establishing the full extent of the buried features. Therefore in summary, the use of the *Grad601-2* has proven to be a complete success and as such, it is hoped that the process will we rolled out across the entire extent of the Purton site with the view to fixing the positions of both known and unknown archaeology.

5:6 Further research

In line with the FoP proposed phased schedule, this survey forms part of the ongoing: ongoing programme of in depth archaeological survey and research:

Phase Two: duration 2011 – 2014, Final report submission date 2014

Full DGPS site survey,

Comprehensive programme of historical research and data review,

Full off set archaeological survey,

Comprehensive scale drawing survey,

Photo-mosaic survey,

Full depth probe survey.

Phase Three: duration 2013 – 2015, Final report submission date 2015

Aerial survey,

Full ground penetrating magnetometer survey,

Comprehensive 3D Laser survey,

Limited excavation,

Ongoing annual monitoring programme of decomposition.

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[10] Robert Schopland, Purton photographs, The Friends of Purton,

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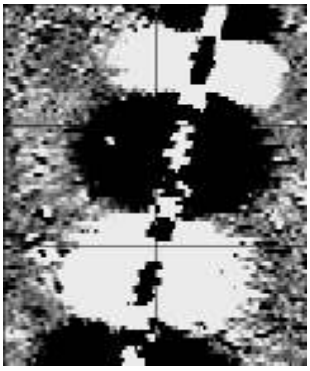
APPENDIX i – Basic principles of magnetic survey – Stratascan Ltd

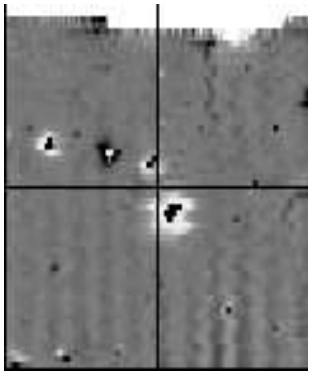
Detailed magnetic survey can be used to effectively define areas of past human activity by mapping spatial variation and contrast in the magnetic properties of soil, subsoil and bedrock. Weakly magnetic iron minerals are always present within the soil and areas of enhancement relate to increases in *magnetic susceptibility* and permanently magnetised *thermoremnant* material. Magnetic susceptibility relates to the induced magnetism of a material when in the presence of a magnetic field. This magnetism can be considered as effectively permanent as it exists within the Earth's magnetic field. Magnetic susceptibility can become enhanced due to burning and complex biological or fermentation processes. Thermoremnance is a permanent magnetism acquired by iron minerals that, after heating to a specific temperature known as the Curie Point, are effectively demagnetised followed by re-magnetisation by the Earth's magnetic field on cooling. Thermoremnant archaeological features can include hearths and kilns and material such as brick and tile may be magnetised through the same process. Silting and deliberate infilling of ditches and pits with magnetically enhanced soil creates a relative contrast against the much lower levels of magnetism within the subsoil into which the feature is cut. Systematic mapping of magnetic anomalies will produce linear and discrete areas of enhancement allowing assessment and characterisation of subsurface features. Material such as subsoil and non-magnetic bedrock used to create former earthworks and walls may be mapped as areas of lower enhancement compared to surrounding soils. Magnetic survey is carried out using a fluxgate gradiometer which is a passive instrument consisting of two sensors mounted vertically either 0.5 or 1m apart. The instrument is carried about 30cm above the ground surface and the top sensor measures the Earth's magnetic field whilst the lower sensor measures the same field but is also more affected by any localised buried field. The difference between the two sensors will relate to the strength of a magnetic field created by a buried feature, if no field is present the difference will be close to zero as the magnetic field measured by both sensors will be the same. Factors affecting the magnetic survey may include soil type, local geology, previous human activity, disturbance from modern services etc.

APPENDIX ii – Glossary of magnetic anomalies



Stratascan Ltd

Bipolar: A bipolar anomaly is one that is composed of both a positive response and a negative response. It can be made up of any number of positive responses and negative responses. For example a pipeline consisting of alternating positive and negative anomalies is said to be bipolar. See also dipolar which has only one area of each polarity. The interpretation of the anomaly will depend on the magnitude of the magnetic field strength. A weak response may be caused by a clay field drain while a strong response will probably be caused by a metallic service.

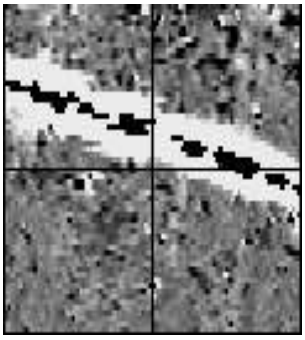


Dipolar: This consists of a single positive anomaly with an associated negative response. There should be no separation between the two polarities of response. These responses will be created by a single feature. The interpretation of the anomaly will depend on the magnitude of the magnetic measurements. A very strong anomaly is likely to be caused by a ferrous object.

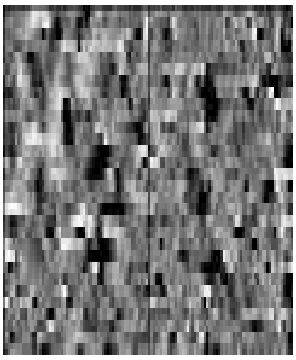
Positive anomaly with associated negative response: See bipolar and dipolar.

Positive linear: A linear response which is entirely positive in polarity. These are usually related to in filled cut features where the fill material is magnetically enhanced compared to the surrounding matrix. They can be caused by ditches of an archaeological origin, but also former field boundaries, ploughing activity and some may even have a natural origin.

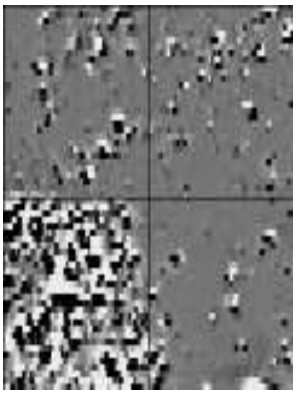
Polarity: Term used to describe the measurement of the magnetic response. An anomaly can have a positive polarity (values above 0nT) and/or a negative polarity (values below 0nT).



Positive linear anomaly with associated negative response A positive linear anomaly which has a negative anomaly located adjacently. This will be caused by a single feature. In the example shown this is likely to be a single length of wire/cable probably relating to a modern service. Magnetically weaker responses may relate to earthwork style features and field boundaries.



Positive point/area: These are generally spatially small responses, perhaps covering just 3 or 4 reading nodes. They are entirely positive in polarity. Similar to positive linear anomalies they are generally caused by in filled cut features. These include pits of an archaeological origin, possible tree bowls or other naturally occurring depressions in the ground.

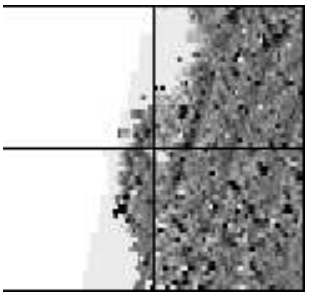


Magnetic debris: Magnetic debris consists of numerous dipolar responses spread over an area. If the amplitude of response is low (+/-3nT) then the origin is likely to represent general ground disturbance with no clear cause, it may be related to something as simple as an area of dug or mixed earth. A stronger anomaly (+/-250nT) is more indicative of a spread of ferrous debris. Moderately strong anomalies may be the result of a spread of thermoremnant material such as bricks or ash.

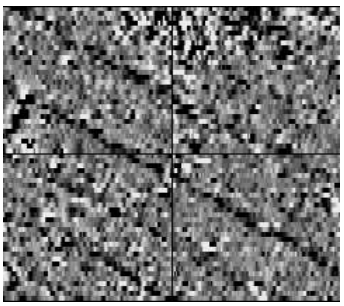
Thermoremnant response: A feature which has been subject to heat may result in it acquiring a magnetic field. This can be anything up to approximately +/-100 nT in value. These features include clay fired drains, brick, bonfires, kilns, hearths and even pottery. If the heat application has occurred insitu (e.g. a kiln) then the response is likely to be bipolar compared to if the heated objects have been disturbed and moved

relative to each other, in which case they are more likely to take an irregular form and may display a debris style response (e.g. ash).

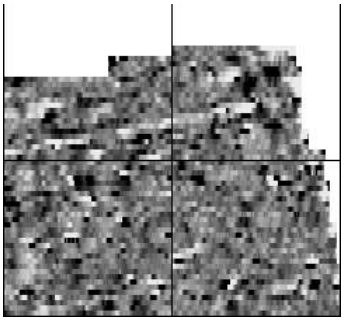
Strength of response: The amplitude of a magnetic response is an important factor in assigning an interpretation to a particular anomaly. For example a positive anomaly covering a $10m^2$ area may have values up to around 3000nT, in which case it is likely to be caused by modern magnetic interference. However, the same size and shaped anomaly but with values up to only 4nT may have a natural origin. Trace plots are used to show the amplitude of response.



Magnetic disturbance: Magnetic disturbance is high amplitude and can be composed of either a bipolar anomaly, or a single polarity response. It is essentially associated with magnetic interference from modern ferrous structures such as fencing, vehicles or buildings, and as a result is commonly found around the perimeter of a site near to boundary fences.

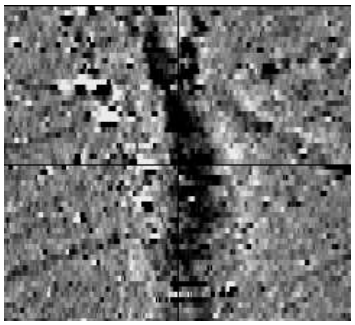


Ploughing activity: Ploughing activity can often be visualised by a series of parallel linear anomalies. These can be of either positive polarity or negative polarity depending on site specifics. It can be difficult to distinguish between ancient ploughing and more modern ploughing, clues such as the separation of each linear, straightness, strength of response and cross cutting relationships can be used to aid this, although none of these can be guaranteed to differentiate between different phases of activity.



Negative linear: A linear response which is entirely negative in polarity. These are generally caused by earthen banks where material with a lower magnetic magnitude relative the background top soil is built up. See also ploughing activity.

Negative point/area: Opposite to positive point anomalies these responses may be caused by raised areas or earthen banks. These could be of an archaeological origin or may have a natural origin.



Weak background variations: Weakly magnetic wide scale variations within the data can sometimes be seen within sites. These usually have no specific structure but can often appear curvy and sinuous in form. They are likely to be the result of natural features, such as soil creep, dried up (or seasonal) streams. They can also be caused by changes in the underlying geology or soil type which may contain unpredictable distributions of magnetic minerals, and are usually apparent in several locations across a site.