William E. Connor Foundation,

***The Battle of the Boyne* (1693) by Jan Wyck**

Conservation and Research Project Report

The Battle of the Boyne, (1693) by Jan Wyck, before-treatment in normal light.

The Battle of the Boyne, (1693) by Jan Wyck, after-treatment in normal light.

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The Battle of the Boyne by Jan Wyck, 1693,

Oil on canvas 223 x 386.5 cm

The Boyne Valley, on the border between counties Meath and Louth, was a theatrical setting for the confrontation between King William III and King James II on 1 July 1690 (according to the Julian calendar). In this painting completed three years after the battle, Jan Wyck provides a panorama of the Oldbridge battle site, form the vantage point of the Williamites, based on the Tullyallen slopes to the north of the River Boyne, looking southwards towards Donore Hill where James II and his troops were based. Approximately 61,000 horse and foot regiments converged in this valley for battle: c.25,000 Jacobites facing c.36,000 Williamites, making it one of the largest military engagements in Ireland's history. Focused on commemorating the victors, Wyck placed the Williamite troops and their weapons centre stage. William III is shown, mounted on a bay horse, in the right foreground wearing a blue-grey coat and brandishing a sabre. The insignia of the Order of the Garter is visible on his coat. He is accompanied by a group of military generals and members of his personal bodyguard, the Dutch home-guard.

In terms of casualties the Battle of the Boyne was a relatively minor military engagement: some 1,500 out of an approximate total 61,000 troops were killed or seriously injured. Nor was the battle a decisive military encounter; the Jacobites engaged in a fighting retreat, and while James fled to France, his army advanced to Limerick before being decisively defeated at the Battle of Aughrim a year later. Although the painting is topographically accurate, evidence of Wyck's presence in Ireland has yet to be discovered. It is likely that he based his painting on the work of fellow Dutch artist Dirk Maes, an eyewitness to the battle. Wyck painted a number of smaller versions of the Battle of the Boyne, but this is the largest and most elaborate example of his Boyne painting.

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The Battle of the Boyne Conservation and Restoration Project

Technical Report

The restoration of National Gallery of Ireland (NGI) painting no. 988 *The Battle of the Boyne* (1693)by Jan Wyck, in-situ at the Great Hall, Malahide Castle, County Dublin. The project scope encompassed:

- Practical treatment of the painting – structural and aesthetic restoration.
- Historical research into the provenance and material history of the painting.
- Analysis of materials used in the painting.
- Development of social media and public engagement programmes.
- Assessment and implementation of preventive conservation measures for the painting.
- Engagement with sister institutions for the purposes of research development.
- Collaboration with the NGI Digital Media department to develop a project web resource.
- Public presentation of regular project updates in the form of regular public lectures.
- Production of written and photographic documentation of the project.

1) Painting Identification Information:

NGI number:	988
Artist:	Jan Wyck (1652-1702)
Title:	The Battle of the Boyne
Medium/Support:	Oil on canvas
Dimensions:	Unframed: 219 x 302 cm H x W. Framed: 239 x 322 x 7 cm H x W x D

2) Location of Painting

For the duration of the project, the painting was located in the Great Hall of Malahide Castle. Malahide Castle and Gardens are managed by Shannon Heritage Ltd. Malahide Castle Demesne and Regional Park is under the governance of Fingal County Council. The painting hangs in the oldest part of the building on the North wall of the Great Hall. It is hung from two iron rods fixed to either side of the frame (on the reverse) and suspended from a metal rail which is bolted into the wall. The painting has not been moved since installation by the National Gallery in 1976. See Appendix 1 Plate 1 for image of painting before treatment.

3) Technical Examination

1. Methodology

A range of analytical techniques were employed to examine the painting materials, how they were applied and how they have degraded over time. Visual examination and imaging of the painting was conducted using normal light and ultra-violet light. See Appendix 1 Plate 4 for ultraviolet image. Cross-section samples of paint and ground layers were taken from a range of locations across the painting to include each of the visually identifiable pigments and a selection of layer build-up sequences. Paint and ground samples were set in resin and photographed in cross-section under normal, incident light at 200x magnification. See Appendix 2.1 and 2.2 for sample site diagram and cross section analysis. SEM-EDS (Scanning Electron Microscopy coupled with Energy Dispersive Spectroscopy) was conducted on a selection of samples to identify inorganic pigments and additives used in the ground and paint layers. SEM-EDX facilities were sourced at The Centre for Microscopy and Analysis at Trinity College Dublin. Cross sections were subjected to micro-chemical staining tests for binding medium identification using Rhodamine-B and Amino-Black staining solutions. See Appendix 2.3 for staining images. Samples of original and lining canvas were taken and submitted for analysis at the National Museum of Ireland textile conservation unit. See Appendix 2.4 for canvas analysis.

2. Analytical Findings

Visual and Photographic Inspection

Visual examination in normal light confirmed that the varnish layer had discoloured across the surface and that old restorations had discoloured to become visibly disturbing. Unfilled paint losses and localised planar deformations were clearly visible under normal light. Access to the back of the canvas was restricted due to the in-situ nature of the project. Surface examination of the original canvas support confirmed the presence of a central horizontal join between two component canvas pieces. Canvas edges within the picture plane indicated that the original canvas had been lined at least once onto a secondary support. The secondary support is visible (2 - 4cm width) within the sight edges.

Under visual examination in ultraviolet light the varnish coating fluoresced a pale yellow-green colour - consistent with the behaviour of natural resin and wax varnish. Solubility tests further confirmed that the varnish was natural-resin based. Ultraviolet imaging also confirmed the non-original nature of

restorations which appeared dark on top of the fluorescing varnish layer. There was no visible florescence of pigments consistent with the behaviour of organic molecule compounds which would have indicated the presence of lake pigments. Highlights in the sky appear bright blueish white under UV, suggesting the use of Lead white in these passages. (See Appendix 1.4 for ultra-violet image).

Inorganic Pigment Analysis

Elemental analysis coupled with microscopic examination and literature referencing allowed for identification of some inorganic pigment and paint additives components. See Appendix 2.2 for table of findings. Evidence suggests that the pigment palette used for this painting consisted of Lead white; bone black; vermillion red; realgar; red, yellow and brown earth. Blue pigments may include blue-smalt, ultramarine, or blue-earth 'vivianite'. Paint and ground additives included compounds of calcium carbonate, silica and magnesium. These materials are commonly mentioned in seventeen century Northern European painting treatise such as the De Mayerne manuscript.[i] Jan Wyck was trained under his father in the Dutch-British painting technique which evolved in England during the seventeenth and eighteenth centuries. The pigments identified in this examination are on the whole typical of what was used during this period.

High EDS spectra peaks for Silica and Cobalt in both ground and paint layers indicate the prolific presence of blue smalt pigment and silica-based additive. Silica in the form of finely ground glass was recommended in historic artists' treaties as it improved the translucence and luminance of paint layers. More practically, silica also served to quicken the drying process of oil paint, a welcome aide when completing a painting as large as this. The characteristic darkening of smalt in oil medium can be seen across the landscape and sky, where once bright blue or rich green passages of paint are now leached of colour and appear pale or neutral in tone. Smalt was the most commonly used blue pigment during the seventeenth century. Analysis of a painting attributed to Jan Wyck's student John Wootton showed similar use of smalt[ii]. A different type of blue pigment was visible in microscopic examination of samples 988.1, 988.6 and 988.7. See Appendix 2.1. The absence of sodium peaks in EDS analysis make the identification of this pigment as Ultramarine problematic. Particle shape and behaviour coupled with the pre-1720 date of this painting rules out the presence of *Prussian blue*.[iii] The irregularly shaped blue particles have low tinting strength and produce high EDS spectra peaks for Fe. It is possible that this pigment is blue earth, also called 'vivianite'. Although not commonly used, vivianite was mined in Cornwall during the seventeenth century and has been found in British paintings of a similar date.[iv]

The suggested presence of realgar relates to red-orange particles found in samples 988.4 and 988.9 where EDS spectra peaks for Arsenic and Sulphide were strongly identified. See Appendix 2.1. Orpiment was listed in Thomas Bardwell's pigment list of 1756 and has been found in a small number of paintings made in England and Scotland in the seventeenth century.[v]

Implications for Painting Technique

All complete cross section samples show the consistent presence of a double ground layer and no more than two subsequent paint layers - indicating that Wyck painted with efficiency and economy in mind. Both ground layers contain chalk and silica, Lead white, bone black and earth pigments. The lower ground layer is a red brown in colour and less medium rich. The upper layer contains a higher proportion of Lead white, less red and yellow pigmentation and a higher proportion of oil medium (see Appendix 2.3 for staining test). On top of the ground layers, base paint layers are applied according to specific sections of the painting. For example, cross sections 988.3/3.1 taken from the an area of cloud presents a thick, grey-blue base-layer containing carbon black which is followed by an upper layer of pink containing vermillion and translucent glassy silica.

Similarly in sample 988.10 taken from the foreground, a brown layer is applied as a based on top of which the green landscape details are added. This method of laying down a base layer, distinctive to a certain zone of a painting, is typical of the seventeenth-century Flemish Mannerist style of landscape painting.[vi]

Wyck reserved more expensive pigments such as vermillion and orpiment (sample 988.4) and vivianite or ultramarine (988.7) to detail important details such as uniforms worn by King William and his entourage. This disciplined practice of painting further supports the idea that Wyck was painting in an economical manner and could suggest a prescribed workshop methodology such as would be employed in order to complete multiple large scale commissions.

Canvas Fibre Analysis

Analysis of fibres from both the original and lining canvas was carried out at the National Museum of Ireland textile conservation laboratory. Findings confirmed that both canvases are linen-based. (See Appendix 2.4).

Medium Analysis

Micro-chemical staining tests for both oil and protein were conducted on samples of paint and ground. Materials tested positive for both oil and protein (see Appendix 2.3). It is likely that the strong presence of proteinaceous material is due to impregnation of lining adhesive and paint consolidant into paint and ground layers.

4) The Treatment

Treatment of the painting was subdivided into 6 focus areas namely: The Sky and Landscape Left; The General on Horseback; the Jacobites; The Troops; The Williamites; The Sky and Landscape Right. The conservation treatment of each area involved cleaning, repairing, retouching and varnishing stages. The treatment overview of each section is detailed below:

Area 1 The Sky and Landscape left

The first stage of treatment was cleaning, which involved the removal of surface dirt, varnish and brown (non-original) toning material from the paint surface. The surface dirt was a yellowish brown - suggesting tobacco staining had occurred. It was easily removed using 2% tri-ammonium-citrate aqueous solution and cleared with deionised water. The varnish layer was identified as a natural resin - based on ultra-violet fluorescence and solvent sensitivity.

After careful testing, ethanol free-solvent was found to solubilize varnish and resinous toning material. Varnish and imbibed dirt in the paint interstices, particularly in areas of bright white and pink paint, was agitated and loosened using mechanical action with a sharp pointed metal needle. Some old over-paint and residual resin varnish beneath the toning layer was not soluble in ethanol free-solvent. In these cases, propan-2-ol carbopol solvent gel applied for 3-5minutes and cleared with ethanol and deionized water, was found to be affective.[vii]

Removal of the varnish and discoloured non-original material produced a positive visual effect, revealing subtle changes in tone across the landscape. Removing yellowed and de-saturated varnish in the sky revealed a much wider range of pink and white tones, restoring contrast between dark and light areas. Removal of discoloured over paint revealed a damaged original surface, with unsightly pale patches in some areas. On close inspection, these appear to be eruptions from a lower layer - possibly lead protrusion from the ground layers. Analysis of samples taken from these areas indicated high levels of Lead and low medium content.

As cleaning progressed, widespread paint losses became apparent. An extensive and very visible network of ageing cracks was visible across the whole the paint surface. The old varnish layer appeared to have been acting as a protective layer for some of the more fragile parts of the painting. Localised consolidation was carried out using 15% sturgeon bladder aqueous adhesive. At the top left edge of the painting, the original canvas was delaminating from the lining canvas. Lifting canvas was softened with heat and moisture, flattened and re-adhered using Evacon-R® EVA adhesive. Associated areas of fragile paint along the top edge were consolidated using 20% sturgeon's glue. Fill material had been very roughly applied to this area in a past restoration. This filler was water-soluble and therefore easily removed using water and mechanical action. These areas were refilled using chalk-gelatine (15% rabbit skin glue) material and retouched in order to even out the top edge of the painting.

Retouching across section 1 was carried out using Schminke® water-colour paints. Dark spotting and dirt-imbibed interstices in the blue sky area were retouched using minimal dotting of colour and thinly-applied brushstrokes in some areas. Interstices which could not be cleaned out due to fragility of the paint, were retouched with tiny dots of colour.

In-painting previously applied to cover a triangular tear-damage in the sky, has discoloured to cause visual disturbance. After varnish removal, the overpaint and excess fill were mechanically removed. Crumbling paint around the edges of the tear repair was consolidated

using 20% sturgeon's glue. Detailed retouching was carried out in the area to integrate the triangular.

Cleaning of the landscape during this stage revealed an original paint surface which had lost its colour and saturation due to years of light damage and over-cleaning. Retouching across the landscape was focused on disguising the disturbance of deep and darkened cracks and areas of wear caused by previous over cleaning and lead soap protrusion. 25% concentration of Meimeri® vernis a retoucher (ketone based resin) was applied to all areas before retouching to provide a low level of saturation to the paint layer. Further varnish tests were carried out on the landscape area to investigate saturation of the leached paint layer. Due to the age and tone of the paint surface low percentage solutions of natural dammar and mastic resins in turpentine were tested alongside synthetic co-polymer Paraloid B72 in white spirit. It was found that a 15% mastic varnish provided good penetration with moderate gloss effect in dark and difficult to saturated areas of the composition. The low percentage - approx. 15% concentration - reduced the yellowing effect associated with mastic.

Area 2 - The General on Horseback

The lower left section, where the General on Horseback figure is located, required cleaning, filling, retouching and re-varnishing. Moderate particulate surface dirt was removed using 2% tri-ammonium-citrate aqueous solution and cleared with deionised water. Identification of the varnish layer as a natural resin based material was consistent with the varnish found in previously cleaned areas. As the varnish had aged to an orangey/matte appearance, it was deemed beneficial to remove this layer. Ethanol, propan-2-ol and acetone were tested in

both free solvent and gel form in order to make sure varnish could be removed without affecting any original glaze layers below.

As with other areas ethanol free solvent was found to be the most affective and easily-controllable method for varnish removal. Over-insistence or use of solvent gels was avoided - due to the risk of blanching in darker areas (due to the higher sensitivity of dark pigments). Discoloured overpaint was identified in some areas. In areas of foliage, an aged blackish/green, non-original, resinous glaze was found. These old restorations were also removed with ethanol free solvent.

Extensive ware and corresponding heavy, non-original glazes were identified in areas of blue paint. The blue tunic of the standing figure with a telescope had suffered from over-cleaning in a previous treatment. A glossy, dark-blue glaze had been applied in a previous treatment, and was hiding any detail of the original paint beneath. This blue glaze was highly soluble in ethanol. The original under layer was carefully examined and it was deemed better to remove later retouching and to better reconstruct the forms of the tunic beneath.

A range of surface accretion material was identified when cleaning this area including remnants of old chalk filler along the left and bottom edge of the canvas. Extensive coverage of minute household paint drips - white and red - were present in dark areas of the foreground. Both materials were removed by softening with white spirit and mechanical scraping. Removal of degraded varnish and over paint revealed tears and damages. A linear damage measuring approximately 60cm and associated paint loss is present 60cm from bottom edge and 50cm from the left. The edges of the paint loss were quite sharply raised although paint was secure at both edges. This damage possibly occurred as a result of the lining or previous rolling process. It was attempted to reduce the lifting paint in this area using a hot spatula at 50°C and some gentle pressure through Melinex. Some improvement was achieved, however it is necessary to reattempt flattening from the reverse when the painting is removed from its' stretcher. A thin layer of fill (chalk-gelatine of 15% rabbit skin glue) was applied to the area of paint loss after flattening. Other small losses and indents were filled and retouched in a similar way.

Varnishing these areas was particularly challenging due to the saturation requirements of darker paint passages. In the paler areas, it was visually appropriate to provide a minimal saturation, avoiding the use of a varnish with any yellow tonality. In the dark areas instead, it was necessary to saturate more deeply while limiting extreme gloss or yellowing.

Area 3 - The Troops

Area 5 'The Troops' features the river Boyne running horizontally left to right and a large amount of detail including many small individual and grouped military figures. The river is painted in bluey-green tones with pale cream highlights and dark shadows. The landscape varies to include rocky outcrops and highlighted plateaus. Many other details such as battle camp vehicles and animated figurative groups are featured. The centre of the composition consists of large military groups in flanking formations. Scattered around are white plumes, rising from the battle field and the artillery below.

The main aim of treatment in this area was to remove yellowed and darkened varnish and toning material which were masking the blue and pale-cream tones in the composition. Varnish removal was carried out using Ethanol and White Spirit free solvents. A heavy layer of dark brown varnish was masking the blue tones of the river. After removal the depths of tone and form were more visually perceptible. In areas of pale, thickly-applied paint, extensive use of scalpel was required to remove dark material imbibed within the interstices of the paint layer. Despite some abrasion and discoloration, much of the detail had survived previous cleaning campaigns. Dark cracks in pale areas of centre battlefield very extensive and visually disturbing.

The most obviously features of highlight in this painting are the clouds of smoke which meander from the artillery explosions in the centre foreground back across the receding hills, echoing the cloud formations in the sky. The use of cloud to organise physical space is one of Wyck's key and most masterful artistic devices in this composition. Retouching in this area focused on the reintegration of fragmented forms in the composition through strategic retouching of crack patterns in pale areas.

Cleaning and retouching of this area of the painting yielded a great deal of detail including finely painted animals and minutely detailed figurative compositions. In order to maintain a

level of animation, Wyck cleverly punctuated the vast painted scene the composition with a variety of small figurative groups and animals. These figures are have become more visible after restoration and they can once again act as focal points of activity and provide information about the realities of battle.

Appendix 1 & 2 – Technical and Material Analysis

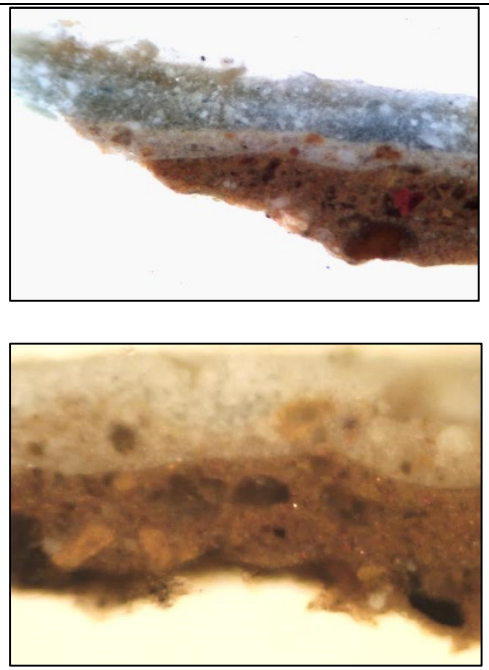
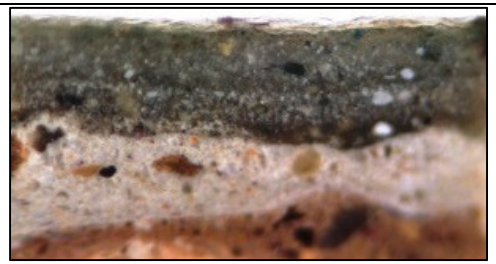
Plate 1. Before-treatment image in normal light of *The Battle of the Boyne*, (1693) Jan Wyck.

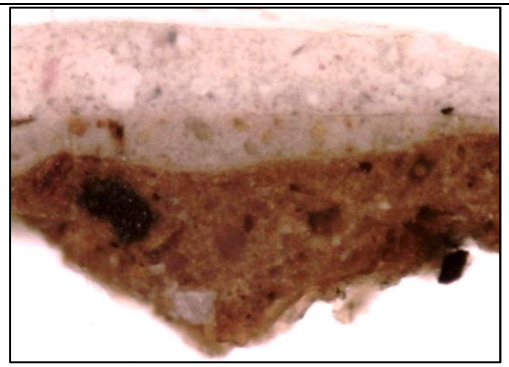
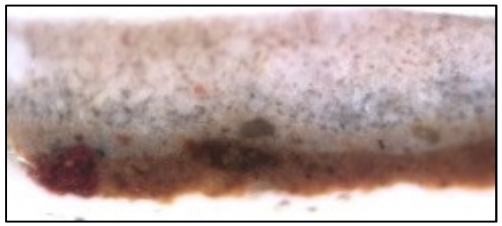
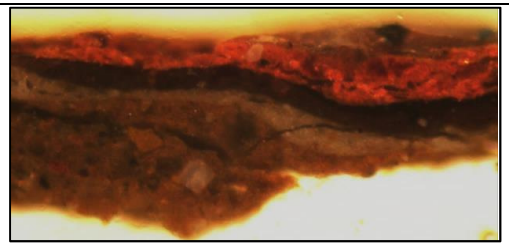
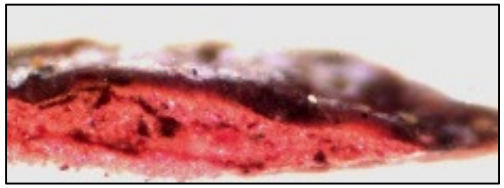
Plate 2. Mid-treatment image #1 in normal light of *The Battle of the Boyne*, (1693) Jan Wyck

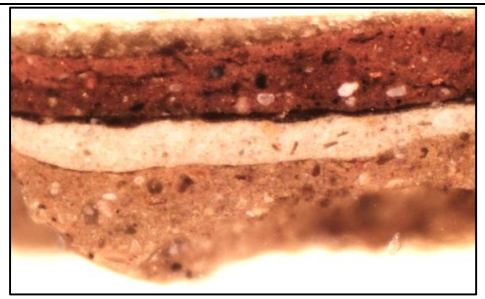
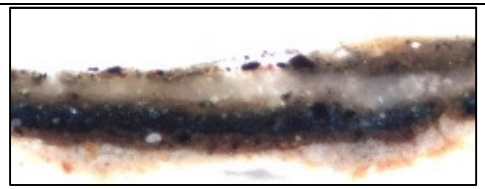
Plate 3. Mid-treatment image #2 in normal light of *The Battle of the Boyne*, (1693) Jan Wyck

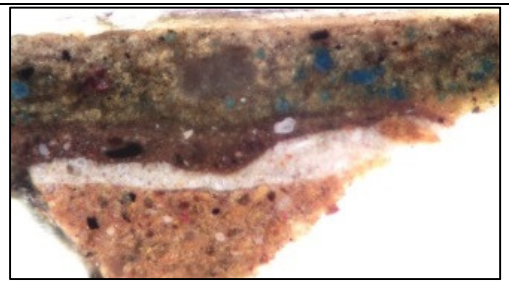
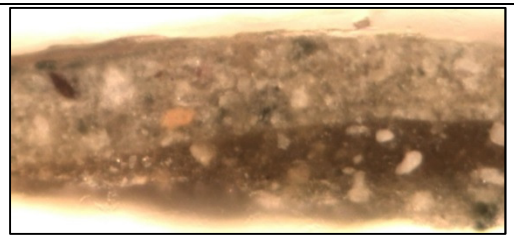
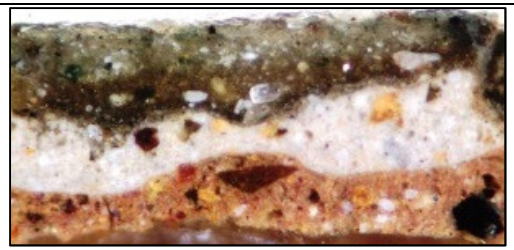
Plate 4. Mid-treatment image in ultraviolet light of *The Battle of the Boyne*, (1693) Jan Wyck

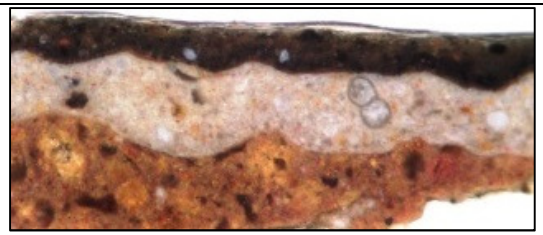
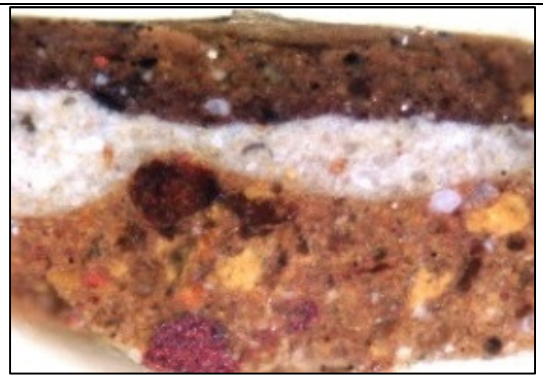
Sample site location

2.2 Data Table of Inorganic Analysis					
Sample ID	**Location**	**Layer Structure**	**Image**	**EDS Findings**	**Suggested Pigments**
988.1/1.1	Blue of sky away from edge.	Ground layer, two paint layers, varnish. 1.1 1a. shows detail of ground layer with large inclusions of yellow earth pigment.		Fe, S, Ca, Pb, K, P, Co, Si, Al.	Smalt Lead white Red and yellow earth Bone black Vivianite Additives: Calcium Carbonate, Silica.
988.2	Blue/green in sky, located at the edge of the canvas	Ground layer, pale grey/brown priming layer, medium rich green layer, silica and Smalt-rich, blue original paint layer; varnish.		N/A	

988.3/3.1	Pink Clouds	Ground layer, pale grey/brown priming layer. Paint layer containing finely-ground white pigment and red tinting particles. 3.1 Shows wet in wet build-up of pink over blue in sky.	 	Pb, Ca, Si, Fe, Co, Sn, Al, P.	Smalt, Lead white Red earth Yellow earth bone black Vivianiteblue Additives: Calcium Carbonate Silica.
988.4	Bright red in rider's jackets	Ground layer, priming, two paint layers, varnish.	 	Ca, Fe, S, Si, As, Hg	Red earth Yellow earth Lead white Bone black Vermillion Orpiament Additives: Calcium Carbonate Silica.

988.5	Dark red of sash on anonymous figure holding telescope.	Ground layer, priming, medium layer, paint layer; varnish.		Si, Ca, Al, K, Fe	Red earth Yellow earth Lead white Bone black Additives: Calcium Sulphate Silica.
988.6	Bright blue of cavalryman's coat	Priming layer, original blue layer, blue overpaint, non-original fill, non-original grey, medium rich layer.		Pb, K, Ca, Al, Si, P, Mg	Lead white Bone black Vivianite blue Smalt Additives: Calcium Carbonate Silica Magnesium Silicate
988.7	Light grey in King William's armour	Ground layer, medium layer, priming layer, paint layer –white matrix with large irregular round shaped black particles, varnish.		Pb, Ca, K, Si, Al, Fe, P, Mg	Lead white Bone black Cobalt blue Vivianite blue Additives: Calcium Carbonate Silica Magnesium Silicate

988.8	Blue, brown overpaint on riders blue sleeve	Ground layer, priming layer, brown paint layer, varnish, non-original paint including bright blue and red-brown particles.		Cu, Si, Pb, Fe, Al, Ca	Copper–based green Brown, red, yellow earth Lead white Additives: Calcium Carbonate Silica
988.9	Green of landscape original	Dark green paint layer, lighter paint layers with yellow inclusions, varnish layer.		Si, Al, Co, As, Pb	Cobalt blue Orpiament Vivianite
988.10	Light green in landscape	Ground layer – red, yellow, black, white inclusions, white priming, dark green/brown paint layer, brighter green layer, varnish.			

988.11	Light green in foreground	Ground layer – red, yellow, black, white inclusions, white priming, deep green paint layer with large white inclusions, pale green paint layer with large green inclusion. Varnish		Si, Pb, Fe, Al, S, K	Smalt Lead white Brown, red, yellow earth Vivianite Additives: Calcium Carbonate Silica
988.12	Dark brown in foreground	Ground layer – red, yellow, black, white inclusions, white priming, dark brown paint layer, varnish.		Pb, Fe, Si, K, Ca, Al	Smalt Lead white Brown, red, yellow earth
988.13	Reddish brown in foreground	Ground layer – red, yellow, black, white inclusions, white priming, red-brown layer, varnish.		N/A	

988.14	Light brown in foreground			Si, Pb, Si, Al, Fe, Ca, Mg, Al,	Smalt Lead white Brown, red, yellow earth

2.3

Micro-chemical Staining-test Results

In order to characterise the binding medium used in the paint and ground layers, micro-chemical staining-tests were conducted on a sample including both layers in cross-section. Two stages of staining were conducted using Amino-black proteinaceous staining solution and Rhodamine B oleic staining solutions respectively.[viii] Protein staining produced a positive result for protein content in both the ground and paint layers (fig 1). This material is likely to be animal glue. It is possible that this glue is non-original and is the result of lining and consolidant adhesive penetrating through the painting structure. A counter-stain for oil with Rhodamine B confirmed the presence of lipid content in the paint and varnish layer. This likely represents oil based paint and oil or wax additives in a non-original varnish layer (fig 2).

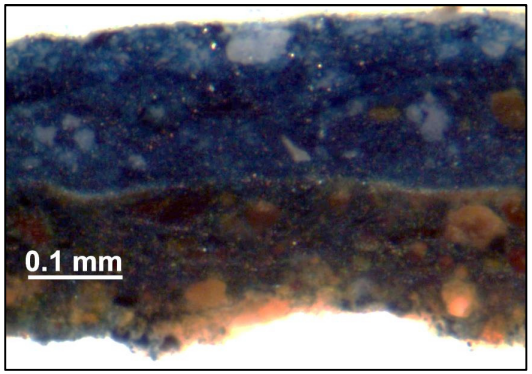


Fig 1 Sample 988.3 after staining with protein identifying solution. This confirms the presence of glue in paint and ground layers.

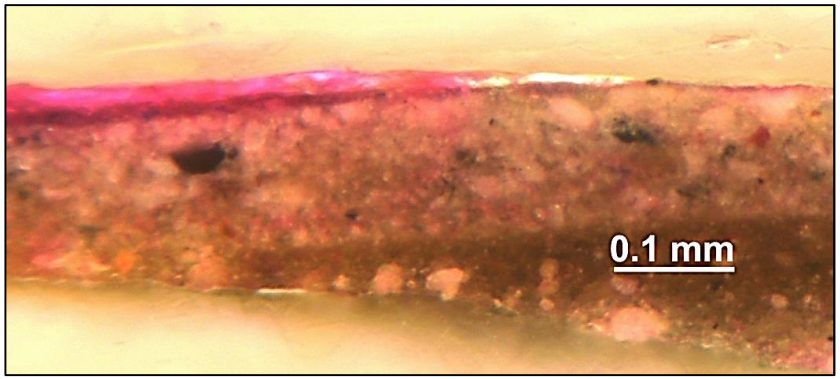


Fig 2 Sample 988.3 after staining with lipid identifying solution – confirming presence of wax or oil in paint and varnish layers.

Fibre identification

Sample: Two sample bags received labelled “NGI 988 original canvas sample” and “NGI 988 lining canvas sample”. The former bag had three distinct samples of c.10mm in length; the latter bag had a number of very small broken fragments of c.1 - 3mm in length.

Preparation: “Original canvas”: one sample was broken in two and each piece was placed on a glass microscope slide. One sample was examined using liquid parafin as a mountant, the other had a mixture of glycerine and water in a 1:1 ratio as a mountant. These are both temporary slide preparations. The different mountants have different refractive indices and so will reveal different surface features of the fibre.
“Lining canvas”: Two samples were prepared in the same way as for the original canvas.

All four samples were examined under magnification using a transmitted light microscope, magnifications used were from x40, x100 and x400.

Results: “Original canvas”: sample appeared to be that of a bast fibre, most likely flax (*Linum usitatissimum*).

“Lining canvas”: sample appeared to be that of a bast fibre, most likely flax (*Linum usitatissimum*). This sample had soiling attached to the fibres which obscured the surface features somewhat. This is understandable if the fabric was used as a lining.

Reference: *Identification of Textile Materials.* 7th Ed. Manchester: The Textile Institute 1985

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[i] de Mayerne, T. Turquet, *Pictoria Sculptoria, Tinctoria et quae subalternarum artium spectantia…1620-46*. British Library MS Sloane 2052, f. 90 [v] - cited in Kirby, J. *The Painter's Trade in the Seventeenth Century: Theory and Practice*. National Gallery Technical Bulletin Vol 20, p. 12.http://www.nationalgallery.org.uk/technical-bulletin/kirby1999

[ii] Unpublished cross section/SEM-EDS analysis of 'The Great Horse' painting (c.1650) attributed to John Wootton at Croome Court National Trust property, Coventry, UK. Monahan, A., O'Sullivan, P, Rutka, F. 2012. SEM-EDS analysis indicated high quantities of Cobalt and Silica in paint and ground layers.

[iii] Hackney, S., Jones, R., and Townsend, J. (eds.), *Paint and Purpose: Study of Technique in British Art*, Tate, 1999, p. 48.Up until the 18th century Smalt was the cheapest and most widely available of the blue pigments. From the 1720's onwards Prussian blue became more cheaply available and commonly used.

[iv] Harley, R.D., *Artist's Pigments* c.1600-1835, p. 57.

[v] West Fitzhugh, E., *Artist's Pigments: A Handbook of Their History and Characteristics*, vol. 3 OXFORD Uni. Press 1997.

[vi] Gifford, M, Style and Technique in Dutch Landscape in the 1620s in Getty Pre-Prints *Historical Painting Techniques, Materials, and Studio Practice*. June 1995P.140

[vii] Wolbers, R., *Cleaning Painted Surfaces: Aqueous Methods*, 2007, p. 121. Solvent gel recipe included 100ml propan-2-ol, 20ml Ethomeen, 2g Carbopol, and 15ml de-ionised water.

[viii] Oil staining was carried out using RHODAMINE B SOLUTION 0.2 % in isopropanol, for TLC derivatization. Protein staining was carried out with Amino Black 10B, Buffalo Black NBR, C.I. 20470 ELECTROPHORESIS REAGENT Product No. N 3393 Sigma Aldrich.