M25 junction 28 improvement scheme
TR010029
6.3 Environmental Statement
Appendix 9.2: Photomontage methodology

APFP Regulation 5(2)(a)
Planning Act 2008
Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

Volume 6
January 2021

Infrastructure Planning

Planning Act 2008

The Infrastructure Planning (Applications: Proscribed Forms and Procedure) Regulations 2009

M25 Junction 28 scheme
Development Consent Order 202[x]

6.3 ENVIRONMENTAL STATEMENT
APPENDIX 9.2: PHOTOMONTAGE METHODOLOGY

Regulation Number:	Regulation 5(2)(a)
Planning Inspectorate Scheme Reference:	TR010029
Application Document Reference:	TR010029/APP/6.3
Author:	M25 junction 28 improvement scheme project team, Highways England

Version	Date	Status of Version
1	21 January 2021	Deadline 1
0	July 2020	Procedural decision

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9. Photomontage methodology

M25 Jct28

Appendix: Technical Methodology

January 2021

Overview
The process of generating verified views (also referred to as accurate visual representations (AVR)) for the Proposed Development at M25 Junction 28 was carried out in conjunction with Troopers Hill (THL).

High quality/resolution photographs were taken from the agreed locations by Troopers Hill. An adequate number of visible features were subsequently surveyed, including the precise location and bearing of the camera. A geo-referenced development model was constructed to OSGB36. With a known camera position and orientation, photographic and surveyed existing visible features, the development model was accurately aligned to the photograph.

The AVRs produced have an estimated accuracy tolerance of +/-10cm.

The pages in this document should be printed at their intended size and not be scaled to fit smaller page sizes. Technical Methodology pages should be printed on A3 landscape paper (297mmx420mm), and the existing / proposed panoramic visualisations should be printed on 297mmx841mm paper.

The panoramic visualisations presented are cylindrically projected and for correct perspective viewing should be viewed with one eye closed and curved through an arc of 90 degrees, while viewed at a constant distance of 500mm.

Site visit
Troopers Hill visited the site on the 22nd June, 1st July and 1st December 2020 to obtain viewpoint photography. The view positions were marked with paint and documented using photography of the exact positions. A survey was also performed on the same visit to record the precise co-ordinates of camera and control points.

Technical Methodology
This section explains in detail the processes involved in the preparation of Accurate Visual Representations (AVR) The following procedures set out an efficient, consistently accurate, robust, repeatable and traceable approach to achieve a high level of accuracy.

Verified photomontages, also referred to as Accurate Visual Representations (AVR) or Visually Verified Montages (VVM), are the 'top level' in terms of accuracy and documentation. Verified imagery is relied upon at public inquiry and in support of contentious planning applications/appeals and must therefore be robust and free from erroneous/ambiguous information. From the outset, a project where verified photomontages are required MUST be approached with the intention of absolute precision and will be based upon a traceable data set.

Standards
The work fully complies with the following guidance:

1. The Landscape Institute/IEMA Guidelines for Landscape and Visual Impact Assessment (3rd edition 2013);
2. The Landscape Institute TGN 06/19 Visual representation of development proposals (published 17 September 2019);
3. The SPG London View Management Framework (March 2012).
4. While The Landscape Institute TGN (public consultation Draft) 2018-06-01 has been considered, the LI states that it should not be taken as de facto guidance from the Institute until the new TGN is issued.

Preparation
Following a formal instruction from the client, the scope of the project was agreed. The client identified a number of viewpoints and supplied a map of required view locations.

Focal length, image format, required content and context and AVR was agreed prior to the site visit. The photographer was familiar with the scope of the project and read any relevant information that was made available by the client.

Photography
The site visit was done on 22nd June, 1st July and 1st December 2020, and consideration was made to:
1. Forecast weather conditions
2. Shot itinerary based on sun position/time of day
3. Access / distance to site / duration of journey to site and required time on site
4. Suitable parking

Equipment used (see Appendix B for specification):
1. Camera, in working order with charged batteries (Canon EOS 5DS R)
2. Empty CF cards, at least 3x32Gb cards and 128Gb across additional cards in various capacities in case of failure
3. Battery charger
4. 50mm lens (Canon EF 50mm f/1.4 USM)
5. Lens cloth
6. Remote cabled shutter release
7. Tripod with indexed/panoramic head (Manfrotto 303)
8. Tripod head levelling base (Manfrotto 438)
9. Small magnetic spirit level
10. Plumb bob
11. Spray paint (upside down street marking paint)
12. Hilti nails / pegs and hammer
13. Tape measure

Lens Selection Criteria
In order to capture appropriate and relevant context, it was agreed that a 50mm lens should be used in combination with a panoramic tripod head. A series of shots were taken (with the camera in portrait orientation) to form panoramic photographs for each view location.

On site procedure
1. Based on the order of viewpoints on the itinerary, each view location was visited. The tripod was erected and camera attached, along with the 50mm lens, shutter release, spirit level and plumb bob. The bob was hung from the bottom of central tripod assembly after a nodal point adjustment had been made.
2. The height of the lens' central axis above ground level was measured and set to 1.60m using the tape measure.
3. A spray paint mark was used directly below the plumb bob to mark the location for the surveyor to measure.
4. Using a camera phone 4 shots (n,e,s,w) were taken of the assembled tripod, camera and bob in situ over the marker. A shot of the marker was also captured.
5. The following camera settings were used:

- Manual 'M' mode
- Bracket set to +/- 0.75 stops
- Aperture at f8 to ensure wide depth of field and minimal diffraction.
- ISO <100
- Auto White Balance (AWB)
- Evaluative metering
- RAW capture only to avoid loss of dynamic range and image quality degredation associated with 8bit jpeg format
- Enabled highlight warning
- Check that TS-E lens is not 'tilted' or shifted if in use
- Used 'Live View' and zoom function to fix and verifiy focus on the site, This also enables 'mirror lockup' and therefore less camera shake.
- Evaluative metering.

Panoramic Shots:
1. A sufficient horizontal field of view was determined to include the site and sufficient relevant context, vertical field of view was also considered based on height of the proposals and proximity to the site - the views were very close to the site, so the camera was set in portrait orientaion.
2. The tripod was levelled using the tripod mounted level. Following this the panoramic tripod head was levelled using the levelling base. The levelling base was microadjusted by partially engaging the clamp. Using the digital level built in to the camera, pitch and yaw angles were adjusted to achieve level. Levels were checked at the mid point and each end of the panorama. A trial sweep of the panorama was performed while checking the digital level to ensure a perfectly level set of shots.
3. A minimum of 50% shot overlap must was achieved with the camera in portrait orientation. The panoramic tripod head assembly was was adjusted to rotate incrementally at approximately 50% of the total horizontal field of view of the selected lens with the camera is in portrait orientation.
4. The panoramic tripod head was adjusted to centre the lens nodal point to the rotational axis of the tripod. It was important to ensure this is set to the correct measurement in order to avoid parallax.
5. With the camera centred on the site, 'live view' and x10 magnification was enabled and an appropriate point was identified to focus on.
6. Once focused, and accounting for conditions, the correct exposure was achieved by adjusting the shutter speed.
7. The panorama was shot from left to right, taking three bracketed shots per rotational increment, through the panorama attempting where possible to avoid cars and any other moving objects.
8. Shots were previewed to check the quality, focus, highlight warning and histogram for the shots to ensure that a well exposed usable set of photographs had been captured.
9. ETR (expose to the right) method was used to achieve noise free shots - using the histogram and bracketing the shutter speed was adjusted to achieve an over exposed (but not clipped) +0.75 bracket shot.

			Date: 06 January 2021 Drawing Number: XX Drawn by: MP Checked by: AP	Project title: M25 Jct28 Client: Atkins Drawing Title: Technical Methodology

Photography Post Processing
RAW files were processed in Adobe Camera Raw after shot approval in Adobe Bridge. The processed RAW files were then taken into Adobe Photoshop to be stitched and saved as full resolution TIF files. The process was as follows:

Downloading and Reviewing:
1. Downloaded *.CR2 RAW files from CF card using a CF card reader. The files were saved to the appropriate project folder on the network.
2. The tripod and marker shots were downloaded to the same location and depositied in a 'documentation' folder.
3. Shots were reviewed with Adobe Bridge, and selections were made based on sharpness, composition, suitability for stitching and exposure.

Processing:
4. Using Adobe Camera Raw, simple and standard digital photo processing techniques were applied ie sharpening, noise reduction and chromatic aberration correction. Settings were adjusted as necessary to achieve the best exposure, shadow detail and clarity.
5. Using Adobe Photoshop, the processed RAW files were stitched to form a panorama of cylindrical projection.
6. The completed panorama was saved as an 8bit tiff file.

AVR Control (Survey)
The AVR control survey was carried out 22nd June, 1st July and 1st December 2020.

Survey Methodology
Survey Equipment Required (see Appendix B for specification)
- Leica 1200 series GPS Smartnet enabled dual receiver (GPS and GLONASS)
- Leica Total Station (1201 or TS16) 1' accuracy with 1000m reflectorless laser

Field Survey Methodology
- **Camera locations:** where possible, the camera position was used as a setup point for the total station, enabling the re-creation of the view as seen in the imagery and reducing the risk of incorrect interpretation of detail. Connection was via GPS Smartnet derived control points in OSGB datum and grid. 3-4 control stations were used, to ensure long distance accuracies and to identify possible outliers.
- Reference points visible in the photography were measured with reflectorless means from the total station. Where long distance views had suitable detail too far from the camera station, further setups were used closer to the detail. Common visible detail points were observed from different setup points to check and increase accuracy achieved.
- Using realtime correction (RTK) accuracies of camera positions are to the low centimetre, while accuracies of surveyed detail vary due to setup geometry and distance, but will be usually in the low centimetre range and always below 30 centimetres.

Data Processing & Delivery
Data was processed using industry standard software (Leica GeoOffice and TerraModel) to create points listings. Digital photos were taken by the survey Total Station to aid identification of points. All points are to OSGB36 grid and datum, to allow the use of common Ordnance Survey products and industry standard site surveys.

AVR Production
Modelling of the Proposals
A model of the proposed development was provided by the project Architect. A full set of CAD (DWG) floor plans was also made available by the project architect in order to verify the accuracy of the supplied 3D model.

Autodesk 3DS MAX 2019 was used to bring together the proposed scheme model, site plans and consented scheme model to generate a master 3D environment.

Autodesk 3DS Max has poor floating point performance and requires that OSGB36 coordinate based drawings and models need to be reprojected nearer to scene origin (0,0).

A project global shift value (x and y axis) was designated when modelling was started. This value was a coordinate for the centre of the site. All drawings were corrected by the global shift value.

Importing of AVR Control Survey Data
The point data provided by the surveyor for control points and camera location was in e,n,z format and delivered as a *.csv. This data was imported in to 3DS Max using a script and was also corrected to the global shift value. When imported virtual cameras were created where specified in the data, and all control points were positioned where specified in the data.

Aligning the 3D Scene to the Baseline Photography
3DS MAX was used to generate high resolution *renders from the virtual cameras set up in the 3D environment

**Rendering is the process of generating an image from a model (or models in what collectively could be called the 3D environment), by means of computer programs - specifically, in this case Chaos Group V-Ray 3.6 for Autodesk 3Ds Max 2019.*

The virtual camera was configured to match a similar field of view to that of the panoramic baseline photograph.

The render from each camera shows each control point as a red cross. In order for the render to match the cylindrical projection of the photograph it was necessary to render the points to a cylindrical projection (using the spherical camera type in VRay 3.6 by specifying exact horizontal and vertical field of view parameters)

This render of the control points was taken into Adobe Photoshop converted to a smart object and overlayed on to the baseline photograph. The smart object was scaled (uniformly) so that the control point markers aligned to the same objects measured by the surveyor. The position of the smart object was locked so that it could not be moved accidentally.

The baseline photography was then effectively aligned to the 3D environment, and when the proposed model was rendered (in cylindrical projection) from this environment and placed in to the smart object it was therefore automatically correctly positioned in the photograph.

Winter photography was shot later in the year and were aligned to the AVR Control survey data by overlaying to the summer (aligned) photography and matching key visible features. The winter views were then saved as an aligned Photoshop file.

The winter and summer aligned Photoshop files were supplied to Atkins, along with the 3D model and global shift coordinates in order for Atkins to produce the final AVRs.

Output of the finished AVR
The style of AVR was discussed with the client and it was agreed that a mix of fully rendered and wireline visulaisations were required.

For the wireline visualisations a basic outline render was taken in to the aligned smart object. Simple lines were traced demonstrating the maximum mass extents of the proposed scheme. For the fully rendered visualisations a photorealistic render was generated from the 3D model that matched the time of day of the photograph, and subsequently inserted in to the aligned smart object. Masks were applied to the smart object to hide aspects of the proposed scheme that are hidden by existing features.

Using the smart object, the field of view of the baseline photography was calculated, measured and subsequently cropped (non destructively) to a fixed field of view of 90 degrees in the horizontal axis for all views.

Using Adobe InDesign, each completed AVR was presented in a document that conforms with the relevant guidance.

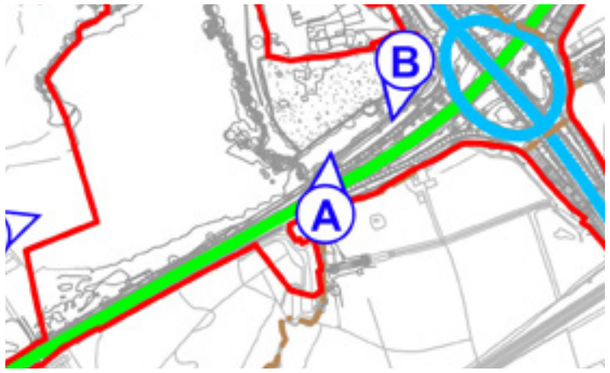
On behalf of Troopers Hill Limited
Braeside, Cotswold Close
Bourne
Brimscombe
Stroud
Gloucestershire
GL5 2UA

			Date: 06 January 2021 Drawing Number: XX Drawn by: MP Checked by: AP	Project title: M25 Jct28 Client: Atkins Drawing Title: Technical Methodology

Viewpoint A AVR Data

Baseline Location and Spatial Data

Mapped Location

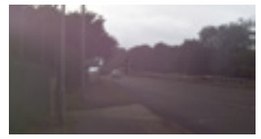
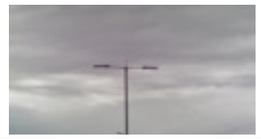
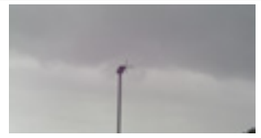


Location Data

Description	Putwell Bridge (facing north)
OSGB36 Location	556457.16 192157.10
Height (AOD)	33.3m
Camera Height	1.65m
Distance to Site	22m
Camera / Lens	Canon 5DS R / 50mm f/1.4 USM
Orientation	Portrait
Format	Panorama
Date	22/06/2020 (summer) / 01/12/2020 (winter)
Time	13:24 (summer) / 12:17 (winter)
Conditions	Good Visibility
Survey Equipment	Leica 1200 Series GPS, Leica TS16 Total Station

Camera Location

Photo Control Point Coordinates (Observed From Survey Instrument)

#	X	Y	Z	Observed Point
100	556454.14	192205.80	34.37	
101	556354.66	192104.28	38.16	
102	556195.92	192032.51	42.22	
103	556405.55	192150.64	44.44	
104	556413.84	192176.34	43.69	
105	556439.78	192169.93	35.73	
106	556438.54	192191.84	35.21	
107	556439.26	192191.38	43.34	
108	556444.22	192347.42	78.76	
109	556470.89	192219.08	35.49	

#	X	Y	Z	Observed Point
110	556473.22	192213.91	40.86	
111	556492.90	192213.65	36.81	
112	556555.25	192267.30	37.25	
113	556605.61	192287.32	39.69	
114	556624.32	192275.51	34.28	
115	556477.66	192166.46	33.29	
116	556473.43	192169.68	32.92	
117	556461.13	192170.37	33.20	
118	556445.10	192161.81	33.49	

			Date:	06 January 2021	Project title: M25 Jct28
			Drawing Number:	XX	Client: Atkins
			Drawn by:	MP	Drawing Title: Viewpoint A AVR Data
			Checked by:	AP	

Viewpoint A Summer Baseline Photography (surveyed extent of panorama)

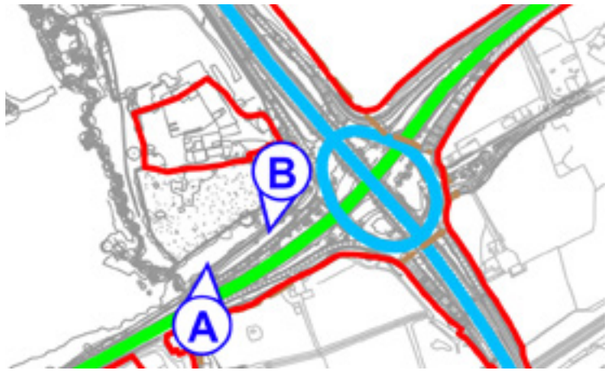
Viewpoint A Winter Baseline Photography

			Date: 06 January 2021 Drawing Number: XX Drawn by: MP Checked by: AP	Project title: M25 Jct28 Client: Atkins Drawing Title: Viewpoint A AVR Data

Viewpoint B AVR Data

Baseline Location and Spatial Data

Mapped Location

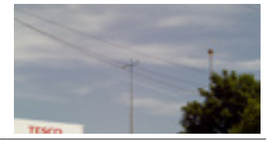
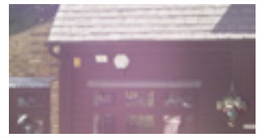
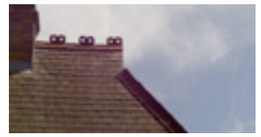


Location Data

Description	Grove Farm (facing south)
OSGB36 Location	556606.14 192400.75
Height (AOD)	36.79m
Camera Height	1.65m
Distance to Site	60.2m
Camera / Lens	Canon 5DS R / 50mm f/1.4 USM
Orientation	Portrait
Format	Panorama
Date	22/06/2020 (summer) / 01/12/2020 (winter)
Time	12:02 (summer) / 10:36 (winter)
Conditions	Good Visibility
Survey Equipment	Leica 1200 Series GPS, Leica TS16 Total Station

Camera Location

Photo Control Point Coordinates (Observed From Survey Instrument)

#	X	Y	Z	Observed Point
D100	556604.05	192408.53	39.56	
D101	556601.35	192435.02	45.51	
D102	556613.72	192422.38	40.8	
D103	556683.99	192458.18	48.83	
D104	556730.79	192430.98	62.06	
D105	556621.62	192398.81	39.17	
D106	556621.01	192391.98	43.69	
D107	556604.22	192379.68	36.75	
D108	556597.95	192393.4	37.59	
D109	556583.42	192398.88	39.26	

#	X	Y	Z	Observed Point
D110	556583.47	192412.95	38.85	
D111	556558.2	192441.7	40.85	
D112	556594.92	192426.36	41.69	
D113	556590.6	192438.98	46.95	
D114	556608.2	192444.28	46.86	

			Date:	06 January 2021
			Drawing Number:	XX
			Drawn by:	MP
			Checked by:	AP

Project title:	M25 Jct28
Client:	Atkins
Drawing Title:	Viewpoint B AVR Data

Viewpoint B Summer Baseline Photography (surveyed extent of panorama)

Viewpoint B Winter Baseline Photography

			Date: 06 January 2021 Drawing Number: XX Drawn by: MP Checked by: AP	Project title: M25 Jct28 Client: Atkins Drawing Title: Viewpoint B AVR Data

Viewpoint C AVR Data

Baseline Location and Spatial Data

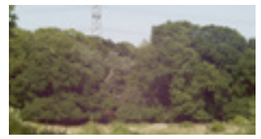
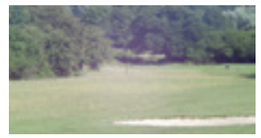
Mapped Location

Location Data

Description	Maylands Golf Course (facing south east)
OSGB36 Location	556025.19 192588.26
Height (AOD)	43.75m
Camera Height	1.65m
Distance to Site	140m
Camera / Lens	Canon 5DS R / 50mm f/1.4 USM
Orientation	Portrait
Format	Panorama
Date	22/06/2020 (summer) / 01/12/2020 (winter)
Time	15:36 (summer) / 13:23 (winter)
Conditions	Good Visibility
Survey Equipment	Leica 1200 Series GPS, Leica TS16 Total Station

Camera Location

Photo Control Point Coordinates (Observed From Survey Instrument)

#	X	Y	Z	Observed Point
C200	556030.85	192611.54	44.02	
C201	556038.49	192603.72	41.86	
C202	556051.18	192600.59	41.97	
C203	556333.6	192696.02	82.72	
C204	556242.18	192656.14	46.82	
C205	556077.06	192581.68	40.68	
C206	556148.74	192529.51	36.82	
C207	556133.04	192521.74	37.72	
C208	556080.42	192535.65	40.22	
C209	556055.78	192531.44	41.75	

#	X	Y	Z	Observed Point
C210	556052.76	192575.02	41.88	

			Date:	06 January 2021
			Drawing Number:	XX
			Drawn by:	MP
			Checked by:	AP

Project title:	M25 Jct28
Client:	Atkins
Drawing Title:	Viewpoint C AVR Data

Viewpoint C Summer Baseline Photography (surveyed extent of panorama)

Viewpoint C Winter Baseline Photography

			Date:	06 January 2021	Project title:	M25 Jct28
			Drawing Number:	XX	Client:	Atkins
			Drawn by:	MP	Drawing Title:	Viewpoint C AVR Data
			Checked by:	AP		

Viewpoint D AVR Data

Baseline Location and Spatial Data

Mapped Location

Location Data

Description	Maylands Cottages (facing east)
OSGB36 Location	555917.69 192100.57
Height (AOD)	50.20m
Camera Height	1.65m
Distance to Site	380m
Camera / Lens	Canon 5DS R / 50mm f/1.4 USM
Orientation	Portrait
Format	Panorama
Date	22/06/2020 (summer) / 01/12/2020 (winter)
Time	13:26 (summer) / 13:02 (winter)
Conditions	Good Visibility
Survey Equipment	Leica 1200 Series GPS, Leica TS16 Total Station

Camera Location

Photo Control Point Coordinates (Observed From Survey Instrument)

#	X	Y	Z	Observed Point
B100	555902.16	192135.57	52.56	
B101	555921.32	192131.43	50.88	
B102	555925.02	192120.5	51.15	
B103	555931.04	192120.75	50.99	
B104	555934.66	192118.88	50.83	
B105	556448.3	192474.52	44.16	
B106	556410.03	192535.39	44.59	
B107	556473.47	192213.97	40.64	
B108	555949.64	192100.41	50.24	
B109	555964.51	192069.64	53.01	

#	X	Y	Z	Observed Point
B110	555931.97	192073.59	54.47	
B111	555913.24	192136.29	50.91	

			Date:	06 January 2021
			Drawing Number:	XX
			Drawn by:	MP
			Checked by:	AP

Project title:	M25 Jct28
Client:	Atkins
Drawing Title:	Viewpoint D AVR Data

Viewpoint D Summer Baseline Photography (surveyed extent of panorama)

Viewpoint D Winter Baseline Photography

			Date: 06 January 2021 Drawing Number: XX Drawn by: MP Checked by: AP	Project title: M25 Jct28 Client: Atkins Drawing Title: Viewpoint D AVR Data

Viewpoint E AVR Data

Baseline Location and Spatial Data

Mapped Location

Location Data

Description	Bridleway south of Nags Head Lane (facing n west)
OSGB36 Location	557127.76 191419.1
Height (AOD)	64.82m
Camera Height	1.65m
Distance to Site	1km
Camera / Lens	Canon 5DS R / 50mm f/1.4 USM
Orientation	Portrait
Format	Panorama
Date	22/06/2020 (summer) / 01/12/2020 (winter)
Time	10:04 (summer) / 11:29 (winter)
Conditions	Good Visibility
Survey Equipment	Leica 1200 Series GPS, Leica TS16 Total Station

Camera Location

Photo Control Point Coordinates (Observed From Survey Instrument)

#	X	Y	Z	Observed Point
A100	556737.53	191433.53	97.52	
A101	556627.57	191779.9	60.84	
A102	556825.51	191679.53	53.72	
A103	556878.16	191729.28	49.5	
A104	556945.01	191780.41	48.44	
A105	556874.66	192194.82	43.3	
A106	556930.79	192176.89	53.67	
A107	557135.01	191747.46	57.91	
A108	557130.95	191429.33	65.87	
A109	557130.84	191422.2	66.14	

Photo Control Point Coordinates (Observed From Survey Instrument)

#	X	Y	Z	Observed Point
A110	556816.13	191604.03	60.29	
A111	556988.6	191742.52	46.91	

			Date:	06 January 2021	Project title: M25 Jct28
			Drawing Number:	XX	Client: Atkins
			Drawn by:	MP	Drawing Title: Viewpoint E AVR Data
			Checked by:	AP	

Viewpoint E Summer Baseline Photography (surveyed extent of panorama)

Viewpoint E Winter Baseline Photography

			Date: 06 January 2021 Drawing Number: XX Drawn by: MP Checked by: AP	Project title: M25 Jct28 Client: Atkins Drawing Title: Viewpoint E AVR Data

Appendix B:
Equipment Specification

Camera: Canon 5DSR

Lens: Canon 50mm f/1.4 USM

Angle of view (horzntl, vertl, diagnl)	40°, 27°, 46°
Lens construction (elements/groups)	7/6
No. of diaphragm blades	8
Minimum aperture	22
Closest focusing distance (m)	0.45
Maximum magnification (x)	0.15
AF actuator	Micro USM¹
Filter diameter (mm)	58
Max. diameter x length (mm)	73.8 x 50.5
Weight (g)	290

Tripod Head: Manfrotto 303PIUS Panoramic Head + 300N Rotation Unit

- sliding plates for nodal point positioning
- Elbow bracket to allow camera to be mounted in either portrait or landscape orientation

Survey GPS: Leica 1200

Receiver	**GX1230**
Type	Dual frequency
Channels	12 L1 + 12 L2 / WAAS / EGNOS
RTK	Yes
Power consumption	5.2W (receiver + controller + antenna)
Batteries	Two Li-Ion 3.6Ah/7.2V mini batteries
	Power receiver + controller + antenna for about 15 hours (static mode)
	Power receiver + controller + antenna + radio for about 10 hours (RTK mode)
External supply	Nominal 12V DC (10.5 to 28V allowed)
Weight	1.20kg
Temperature	Operation: -40 to +65 C, Storage: -40 to 80 C
RTK Accuracy	Horizontal: 10mm + 1ppm, Vertical: 20mm + 1ppm (kinematic)
Post Processed	Horizontal: 5mm + 0.5ppm, Vertical: 10mm + 0.5ppm (static)
Data logging	Compact Flash cards: 256Mb, typical spec:-
	About 4,400 hours L1+L2 logging at 15 sec rate About 17,600 hours L1+L2 logging at 60 sec rate About 360,000 RTK points with codes
Controller	**RX1210T**
Display	High contrast 1/4 VGA touch screen, 11 lines x 32 characters
Keypad	Full illuminated QWERTY keypad with user definable keys
Weight	0.45kg
Temperature	Operation: -30 to +65 C, Storage: -40 to 80 C
Antenna	**SmartTrack AX1202**
Weight	0.44kg
Temperature	Operation: -40 to +70 C, Storage: -55 to 85 C

Survey Total Station: Leica TPS 1201+

Angle measurement

		Type 1201+	Type 1202+	Type 1203+	Type 1205+
Accuracy (std.dev., ISO 17123-3)	Hz, V	1" (0.3 mgon)	2" (0.6 mgon)	3" (1 mgon)	5" (1.5 mgon)
	Display resolution	0.1" (0.1 mgon)	0.1" (0.1 mgon)	0.1" (0.1 mgon)	0.1" (0.1 mgon)
Method	absolute, continuous, diametrical				
Compensator	working range	4' (0.07 gon)	4' (0.07 gon)	4' (0.07 gon)	4' (0.07 gon)
	Setting accuracy	0.3" (0.2 mgon)	0.3" (0.2 mgon)	1.0" (0.3 mgon)	1.5" (0.5 mgon)
	Method	overlayed dual axis compensator			

Distance measurement (IR-Mode)

Range	Round prism (GPR1)	3000 m
(average atmospheric conditions)	360° reflector (GRZ4)	1500 m
	Mini prism (GMP101)	1200 m
	Reflective tape (40 mm x 40mm)	250 m
	Shortest measurable distance	1.5 m
Accuracy / Measurement time	Standard mode:	1 mm + 1.5 ppm / typ. 2.4 s
(standard deviation, ISO 17123-4)	Fast mode:	3 mm + 1.5 ppm / typ. 0.8 s
	Tracking mode:	3 mm + 1.5 ppm / typ. <0.15 s
	Display resolution	0.1 mm
Method	Special phase shift analyser (coaxial, visible red laser)	

PinPoint R400/R1000 reflectorless distance measurement (IR-Mode)

Range	PinPoint R400	400 m / 200 m (Kodak Gray Card: 90 % reflective / 18% reflective)
(average atmospheric conditions)	PinPoint R1000	1000 m / 500 m (Kodak Gray Card: 90% reflective / 18 % reflective)
	Shortest measurable distance	1.5 m
	Long Range to round prism (GPR1)	1000 m – 7500 m
Accuracy / Measurement time	Reflectorless ≤ 500 m	2 mm + 2 ppm / typ. 3 – 6 s, max. 12 s
(standard deviation, ISO 17123-4)	Reflectorless > 500 m	4 mm + 2 ppm / typ. 3 – 6 s, max. 12 s
(objekt in shade, sky overcast)	Long Range:	5 mm + 2 ppm / typ. 2.5 s, max. 12 s
Laser dot size	At 30 m	approx. 7 mm x 30 mm
	At 50 m	approx. 8 mm x 20 mm
Method	PinPoint R400 / R1000	System analyser (coaxial, visible red laser)

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