

— ACCURACY STATEMENT

Accuracy by scan type.

Measured figures by scan type, each with its basis and its limits.

Accuracy is measured on every job and stated per job. The figures below are measured on showcase data: GroundMap processing of public survey data, not client work. None is quoted as the accuracy of another dataset or job; every job carries its own accuracy note.

01 By scan type

SCAN TYPE	MEASURED	BASIS
Drone and ground scanning	USS Pampanito: 98 % of held-out overlap within 1 cm, point to plane.	Laser registration of the 45 terrestrial scans, scored on 124 scan pairs held out of the solve, a fifth of all overlapping pairs: the point-to-plane distance between the two scans is within 1 cm for 98.4 % of matches sampled on flat patches of their shared surface (74.2 % with the registration as supplied).
	El Teniente underground study: within 1 cm on 98.7 % where two or more scans overlap.	44 underground laser scans registered without GPS: each scan within 1 cm of the shared surface, where two or more scans overlap (scans used in the registration; not held out).
Government aircraft LiDAR	43 State survey marks held out of GroundMap's processing: median -3 mm, 33 of 43 within 10 cm, RMSE 0.12 m.	Finished ground against levelled State survey marks; open, relatively flat ground (under 10°, section 07).
GroundMap Fusion, Hobart	On stable open ground, checked independently of the alignment, the 2011 survey agrees with the 2024 survey to a median -6 mm (NMAD 64 mm, 95th percentile 157 mm; 94.4 % within 15 cm): relative agreement between surveys, not absolute accuracy.	The 2011 survey (Mount Wellington 2011) aligned to the 2024 survey, then every 2011 ground return on stable open ground compared with the 2024 ground.
Client jobs	Measured on its own check points and stated in its accuracy note.	Independent check points held out of processing; ICSM v2.0 sections 3.4 to 3.9.

02 Government aircraft LiDAR

CHECK OF THE METHOD · 20 OCTOBER 2026

-3 mm

Median difference, finished ground minus mark, on 43 State survey marks held out of GroundMap's processing.

33 of 43

Marks within 10 cm.

0.12 m

RMSE (RMSEz 0.116 m).

HELD OUT

From all processing, by a rule fixed before any mark was read.

RULES

Set out in section 07; every mark left out is listed with its reason.

DECISIVE

Levelled marks flush with the ground or set in rock.

DISCS

Excluded by a rule fixed before any figure was printed (section 07).

NOT CLAIMED

A quality level, or a certificate for any survey (section 08).

03 Every job: the accuracy note

01 Check points

Independent of control and calibration, on open, level, hard ground, spread across the area: at least the ICSM v2.0 section 3.6.4 count, and 30 or more wherever an ASPRS figure is wanted.

02 Rules first

Counting rules, the point types that decide and the contract's figure, fixed and recorded before any point is read.

03 Both forms

Each point read from a TIN of single returns (ICSM v2.0 section 3.4.1) and on the delivered surface; ICSM non-vegetated vertical accuracy at 95 % and RMSE_v (ASPRS Edition 2); every point left out, with its reason.

04 Sign-off

What was not tested, and who reviewed it. A registered surveyor is engaged wherever a job needs survey sign-off.

04 National form: ICSM v2.0, 95 % confidence

Vertical accuracy, government aircraft LiDAR: GroundMap processing of public survey data. 43 State survey marks held out of GroundMap's processing: median -3 mm, 33 of 43 within 10 cm, RMSE 0.12 m.

GroundMap's finished ground was checked on 20 October 2026 against 43 levelled State survey marks (12 flush with the ground, 31 set in rock; third- and fourth-order levelling; AHD) on open, relatively flat ground (under 10°, by the rules in section 07), held out of GroundMap's processing by a rule fixed in advance. Non-vegetated vertical accuracy (ICSM Australian Airborne LiDAR Acquisition Specification v2.0, 95 % confidence level, $1.96 \times \text{RMSEz}$): 0.23 m (RMSEz 0.116 m). Median difference -0.003 m; NMAD 0.078 m; 33 of 43 (76.7 %) marks within ± 0.10 m and 42 of 43 (97.7 %) within ± 0.30 m; 95th percentile of the absolute difference 0.25 m. At 0.23 m (95 %), the method check is within the 0.30 m vertical limit ICSM v2.0 sets at 95 % confidence.

Limits. A check of the method, not an accuracy statement for any one survey, area or job. No ICSM quality level is claimed. Horizontal accuracy and vegetated ground were not tested. Each reading is the median of ground returns within 1.5 m of the mark, not a TIN interpolation.

Survey marks: LIST Survey Control, the LIST © State of Tasmania, CC BY 3.0 AU. Aircraft LiDAR: public surveys published on theLIST (State of Tasmania) and obtained via ELVIS (Geoscience Australia), under the licences recorded with them (theLIST: © State of Tasmania, CC BY 3.0 AU). Processing: GroundMap.

05 International form: ASPRS Edition 2, RMSE_V

Vertical accuracy, government aircraft LiDAR: GroundMap processing of public survey data. Non-vegetated vertical accuracy, tested against 43 levelled survey marks (State survey control, AHD) held out of GroundMap's processing: **$\text{RMSE}_V = 0.116$ m** (0.1156 m unrounded). Mean error -0.019 m; median -0.003 m; standard deviation 0.115 m; NMAD 0.078 m; 33 of 43 marks within 0.10 m. Reported as found; no accuracy class is claimed.

Checkpoint survey error is not included: the marks publish no height uncertainty. For a checkpoint RMSE of 0.01, 0.02 or 0.03 m, the combined $\text{RMSE}_V = \sqrt{(\text{RMSE}_{V1})^2 + (\text{RMSE}_{V2})^2}$, with V1 the product against the checkpoints and V2 the checkpoint survey, would be 0.116, 0.117 or 0.119 m.

Limits. No source survey holds enough checkpoints to be judged on its own. Vegetated vertical accuracy and horizontal accuracy were not tested. The figure is not converted to a 95 % value, as Edition 2 reports RMSE only, and no USGS quality level is claimed.

Survey marks: LIST Survey Control, the LIST © State of Tasmania, CC BY 3.0 AU.

06 Full statistics

MEASURE	VALUE
Check points	43 levelled State survey marks: 12 flush with the ground, 31 set in rock; third-order (42) and fourth-order (1) levelling; heights on AHD
Median difference	-0.003 m
Mean difference	-0.019 m
Standard deviation	0.115 m
NMAD ($1.4826 \times$ median absolute deviation)	0.078 m
Standard error of the median ($\approx 1.25 \times \text{NMAD} / \sqrt{n}$)	0.015 m
RMSEz	0.116 m

MEASURE	VALUE
95 % (ICSM v2.0, 1.96 × RMSEz)	0.23 m
95th percentile of absolute difference	0.25 m
Within 0.05 m	22 of 43 (51.2 %)
Within 0.10 m	33 of 43 (76.7 %)
Within 0.15 m	36 of 43 (83.7 %)
Within 0.30 m	42 of 43 (97.7 %)
Largest difference	-0.371 m
Checked	20 October 2026

Difference = finished ground minus mark. Non-vegetated, open, relatively flat ground (under 10°, by the rules in section 07); vertical only.

07 Method: a check of the method against held-out State survey marks

- **Held out of processing.** The State's marks were split in two by their State site number, by a rule fixed before any mark was read. The held-out half was never used to align, correct or tune anything, and no height was read from it until the check.
- **Reading rules.** One reading per mark: the median height of the finished ground returns (classes 2 and 8) within 1.5 m of it, minus the mark's AHD height. A mark counts only with at least five ground returns within 1.5 m; no wider window is used. A reading counts on open, relatively flat ground only: slope × 0.30 m within 0.05 m (about 9.5°), under 30 % of the returns within 3 m more than 2 m above the ground, and 3 m or more inside the edge of its 1 km square. Every mark left out is listed with its reason.
- **Levelled marks decide.** Only levelled marks flush with the ground or set in rock decide the figures. Kerb, pit and box marks sit beside a step or below the surface and never decide.
- **Discs excluded by a rule fixed before any figure was printed.** Discs set in concrete, and marks with no description, were to be left out if their median differed from the flush and rock marks' by more than 0.05 m. It did: +0.077 m against -0.003 m. The reading picks up the grass and concrete around a disc rather than the ground, so discs are left out of every figure.
- **The finished ground as output.** The readings were taken on the finished ground exactly as GroundMap's processing writes it out; a sample of readings was cross-checked against a separate export of the same ground, to within 1 mm.

08 Limits: what the check does not prove

- **No quality level claimed.** The check tests the method; no ICSM quality level or accuracy class is claimed for it.
- **Not an ICSM-compliant assessment.** The figure is computed in the ICSM v2.0 form, but the number, distribution and photographic record of the check points fall short of section 3.6 for the area the marks span.
- **Not a certificate for any survey.** No source survey holds enough marks to be judged on its own, and the check certifies no survey, area or job.
- **Not a comparison with the sources.** No claim is made against the source surveys' own stated accuracy.
- **Historic check points.** The State marks serve as historic check points (ICSM v2.0 section 3.6.5): held out of GroundMap's processing, but not surveyed for this purpose and possibly used as control by a source survey's provider, not spread by land cover, and without published height uncertainty.
- **Control use not known.** Whether a source survey's provider used any of these marks as control is not known.
- **Not tested:** horizontal accuracy, vegetated ground, slopes over about 9.5°, ground beside structures, and change between the levelling and the flight.

09 Drone and ground scanning, and GroundMap Fusion

SHOWCASE	SCAN TYPE	MEASURED	BASIS
USS Pampanito	Terrestrial laser scanning, with drone imagery	98 % of held-out overlap within 1 cm, point to plane	Laser registration of the 45 terrestrial scans, scored on 124 scan pairs held out of the solve, a fifth of all overlapping pairs: the point-to-plane distance between the two scans is within 1 cm for 98.4 % of matches sampled on flat patches of their shared surface (74.2 % with the registration as supplied).
El Teniente underground study	Underground laser scanning	Within 1 cm on 98.7 % where two or more scans overlap	44 underground laser scans registered without GPS: each scan within 1 cm of the shared surface, where two or more scans overlap (scans used in the registration; not held out).
Hobart	Government aircraft LiDAR, three surveys fused	Median –6 mm, NMAD 64 mm, 95th percentile 157 mm; 94.4 % within 15 cm	The 2011 survey (Mount Wellington 2011) aligned to the 2024 survey, then every 2011 ground return on stable open ground (slope 10° or less) compared with the 2024 ground, independently of the alignment.

Registration and agreement figures measure how closely scans or surveys agree with each other. Registration agreement between scans, not absolute accuracy against control. The Hobart figure is relative agreement between surveys, not absolute accuracy. On a job they are reported for the job's own scans, beside the residuals at its control and check points. The Hobart model has no figure against survey marks: no levelled mark flush with the ground or set in rock, of those held out, lies within its 2024 survey.

10 Credits and references

- Survey marks: LIST Survey Control, the LIST © State of Tasmania, CC BY 3.0 AU.
- Aircraft LiDAR: public surveys published on theLIST (State of Tasmania) and obtained via ELVIS (Geoscience Australia), under the licences recorded with them (theLIST: © State of Tasmania, CC BY 3.0 AU). Processing: GroundMap.
- USS Pampanito: Showcase: GroundMap processing of public survey data. Survey data: USS Pampanito, Autodesk, Topcon, 3D Robotics, USS Pampanito 2020: USS Pampanito Submarine - LiDAR - Terrestrial, Photogrammetry - Aerial. Distributed by Open Heritage 3D. <https://doi.org/10.26301/qdpd-2250> (CC BY-NC-SA 4.0). Processing: GroundMap. No affiliation with the museum ship's operator or the dataset authors.
- El Teniente underground study: Showcase: GroundMap processing of public survey data. Survey data: Chilean underground mine dataset, Advanced Mining Technology Center (AMTC), Universidad de Chile (Leung et al., IJRR 2017; CC BY-NC-ND 3.0 CL). Processing: GroundMap. No affiliation with the mine operator or the dataset authors.
- Hobart, and the cover image (bare-earth model of the Queens Domain, Hobart): Showcase: GroundMap processing of public survey data, not client work. Survey data: Hobart City 2023/24 (captured by Fugro for the State of Tasmania; theLIST; CC BY 3.0 AU), Climate Futures Derwent 2008 (captured by DiMAP for ACE CRC; ACE CRC licence) and Mount Wellington 2011 (no licence on record), via ELVIS. Processing: GroundMap.
- ICSM, Australian Airborne LiDAR Acquisition Specification, Version 2.0 (2025): accuracy reporting, sections 3.4 to 3.9.
- ASPRS, Positional Accuracy Standards for Digital Geospatial Data, Edition 2 (2023).
- Method and the Fusion grades: GroundMap Fusion methodology, groundmap.com.au/groundmap-fusion/. This statement online: groundmap.com.au/accuracy/.