Adjusting to GDA2020: SCIMS, the NSW State Adjustment and You

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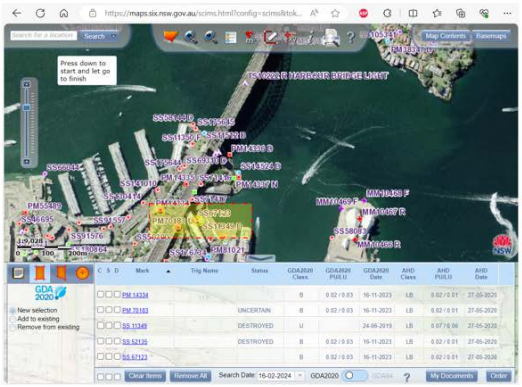
ABSTRACT

This presentation provides an update on the status of the Geocentric Datum of Australia 2020 (GDA2020) in the Survey Control Information Management System (SCIMS) and our progress towards bringing GDA2020 adjusted coordinates with a calculated accuracy to a street-corner near you. SCIMS is currently 'refreshed' every 6 months based on an immense (and ever-growing) 3D least squares network adjustment of more than a million geodetic and survey observations across NSW. This adjustment now underpins the GDA2020 realisation of the NSW survey control network and directly connects local survey marks to the Australian Fiducial Network (AFN), which defines GDA2020. This connection allows the rigorous calculation of Positional Uncertainty (PU) and Local Uncertainty (LU) with respect to datum. Significant automation developed in-house has supported a much faster-than-anticipated re-adjustment of our historic survey data archives from GDA94 to GDA2020, including the majority of street-corner control in urban areas. This feat, originally expected to require 10-20 years, has been largely completed in the 6 years since GDA2020 was defined. We also acknowledge additional process improvements that aim to facilitate the quick turn-around of new data and make SCIMS metadata-rich, leveraging all contributions from the wider survey community. These include improved business-as-usual data flows, a monthly ingestion of AUSPOS submissions, metadata archaeology from our hardcopy archives, and the much-anticipated 'LandXML to SCIMS' project. An added benefit of this 'big picture' perspective has been the easier identification of issues such as stand-point (mis)naming and discontinuities. Currently, SCIMS contains more than 309,000 survey marks (including witness marks and destroyed marks), 69% of which are now 'established' in GDA2020 and of those 72% have Horizontal Positional Uncertainty (HPU). In terms of height, 41% are 'accurate' in the Australian Height Datum (AHD) and of those 64% have an AHD Positional Uncertainty (AHD-PU). Approximately 20% of SCIMS are 'witness' marks or have a status of 'destroyed', 'uncertain' or 'subsidence', but omitting these marks does not significantly alter the statistics reported above.

KEYWORDS: *GDA2020, SCIMS, adjustment, Positional Uncertainty, datum modernisation.*

SCIMS Survey Control Information Management System
What is it?

SIX Maps - SCIMS Online
https://six.nsw.gov.au



Delivers GDA2020 (from July 2019)
Delivers GDA94 (for historic data)

- GDA2020 (3D) and AHD coordinates
- Class, PU, LU (more on this later)
- other useful metadata...

SCIMS SURVEY MARK REPORT AS AT: 16-FEB-2024

Your Reference: null Search Number: 1137137

MARK NAME STATUS	COORDINATES AND HEIGHTS			CLASS	PU	LU	SOURCE	CSF CONVERGENCE AUSGEOID2020
PM 70947	Horizontal coordinates are adjusted (or initialised) in GDA2020							
	MGA2020	308439.445	6183122.367	56 C	0.02	0.03	301416	1.000048
	GDA2020	-34° 28' 32.54033"	150° 54' 50.86549"					-1° 10' 51.89"
FOUND INTACT	GDA2020	Ellipsoidal Height	27.	U			300777	
	AHD71	Normal-Orthometric	6.625	L2A			216391	20.601
TS 12067	Horizontal coordinates are adjusted (or initialised) in GDA2020							
PORT KEMBLA CORS [P]	MGA2020	308399.664	6183139.724	56 3A	0.01	0.02	301416	1.000047
	GDA2020	-34° 28' 31.95059"	150° 54' 49.32102"					-1° 10' 52.75"
RESTRICTED ACCESS	GDA2020	Ellipsoidal Height	34.446	2A	0.02	0.03	301416	
	AHD71	Normal-Orthometric	13.836	A			234136	20.603

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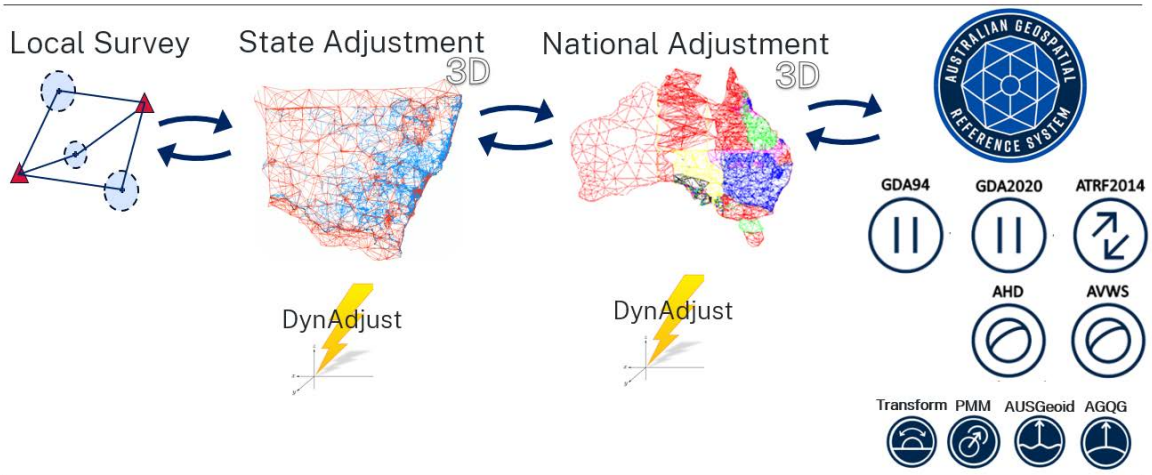
NSW State adjustment
Part of the bigger picture



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NSW State adjustment
A few novel ideas

No HIERCARCHY of control; No primary, secondary, tertiary control
- Control is NOT FIXED, but CONSTRAINED
- Control is allowed to move (within uncertainty)

A single adjustment across NSW
- all available survey measurements are used
- with estimate of accuracy / uncertainty
- rejecting measurements is a last resort; review and re-weight (where appropriate)

Observations have time-stamps
- station movement can be accounted for (with 'discontinuities')

Re-compute as required
- currently run monthly, for internal review
- ~16 hours to crunch the numbers

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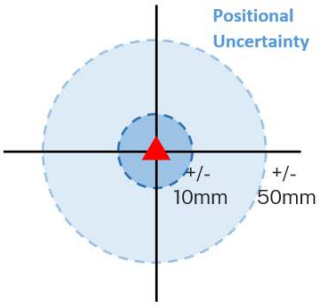
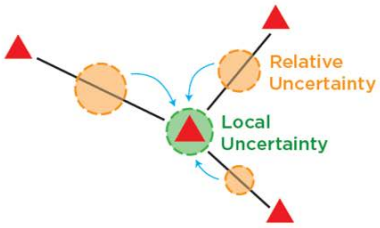
NSW State adjustment
Uncertainty and Class (reported from SCIMS)



Positional Uncertainty (PU)
describes the accuracy of a point with respect to the datum (e.g. GDA2020 or AHD) (95% confidence)



Local Uncertainty (LU)
describes the relative accuracy of a point derived from the survey connections to adjacent points

Class	Typical Application
3A	Special High Precision
2A	National Geodetic
A	State Geodetic
B	State Survey Control
C	Cadastral Survey Control
...	

Table, after SG_Direction_4

Class
describes the planned and achieved precision of a (local) survey network, incl: network design, survey method, equipment, Class of control, intent, mark type ...

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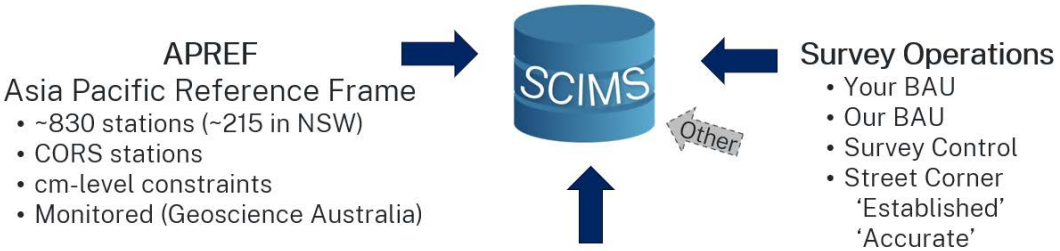
NSW state adjustment
Inputs

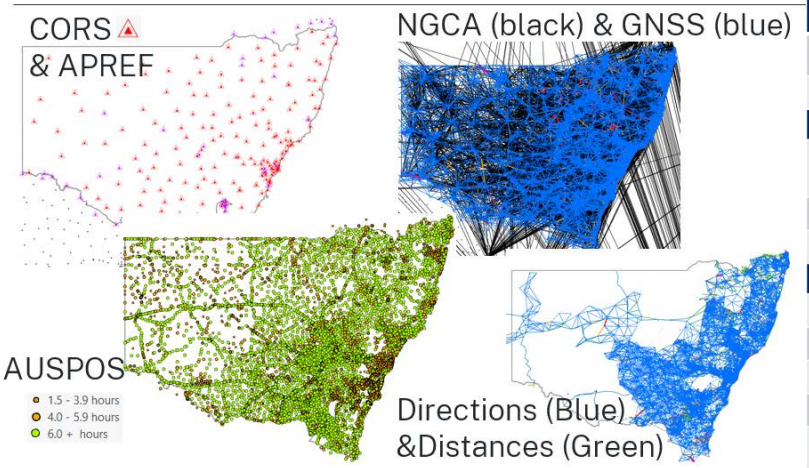


APREF
Asia Pacific Reference Frame
- ~830 stations (~215 in NSW)
- CORS stations
- cm-level constraints
- Monitored (Geoscience Australia)

Survey Operations
- Your BAU
- Our BAU
- Survey Control
- Street Corner
  'Established'
  'Accurate'
- Locality Sketch
- Metadata!

NGCA & AUSPOS
National GNSS Campaign Archive
- long-duration GNSS
- high–density access to datum (good PU)
  'No user more than 5km away'

NSW state adjustment – Inputs
More data than ever before



How many, did you say?!

Item	Count
Total stations	177,000
Total MSR	1,250,000
Stations	
APREF / CORS	830 (~215 in NSW)
NGCA stns	~8,000
AUSPOS stns	~4,400
Measurements	
Xmsr (~NGCA)	71,000 (x, y, z)
Gmsr	360,000 (x, y, z)
Directions	325,000
Distances	340,000
Height (h)	130,000

NSW state adjustment
What's NOT included?

- Not levelling (this is worthy of its own project)
- Not Airborne gravity
- Not LandXML data – **see S. Hine & J. Smith presentation this week!**
- Not for SCIMS marks without survey measures
  - e.g. Dept Main Roads (DMR) plans. Class B, but just GDA94 coords off a plan.
  - Some AGD66 > Tf GDA94 > Tf GDA2020, without data.
- Not (yet) our smaller historical data (e.g. < 10 marks in an adjustment)
- Emerging techniques (e.g. InSAR for deformation) – **see M. Bates presentation this week!**

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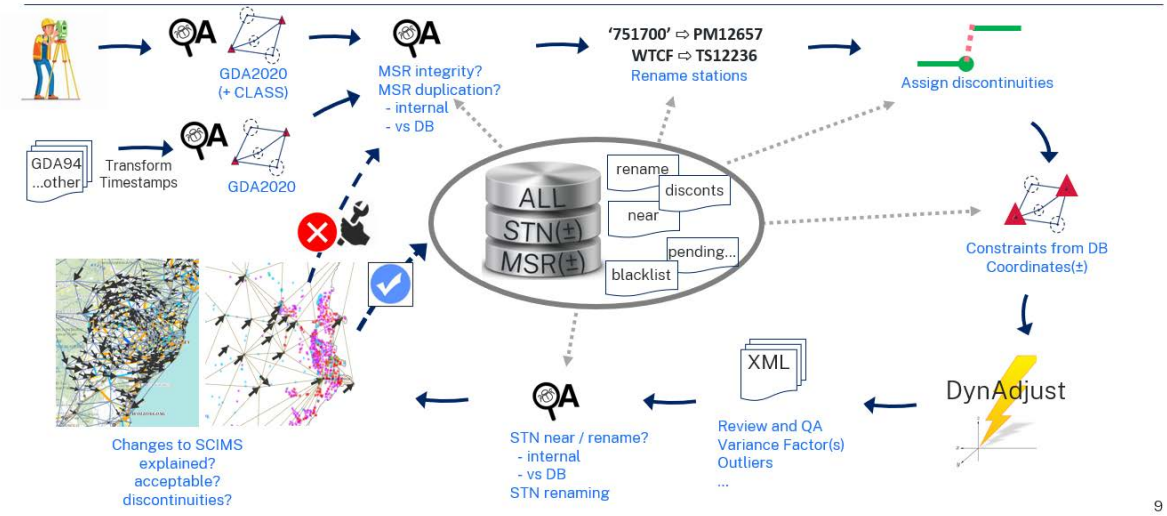
NSW state adjustment – Process
Collate (and QA) the data



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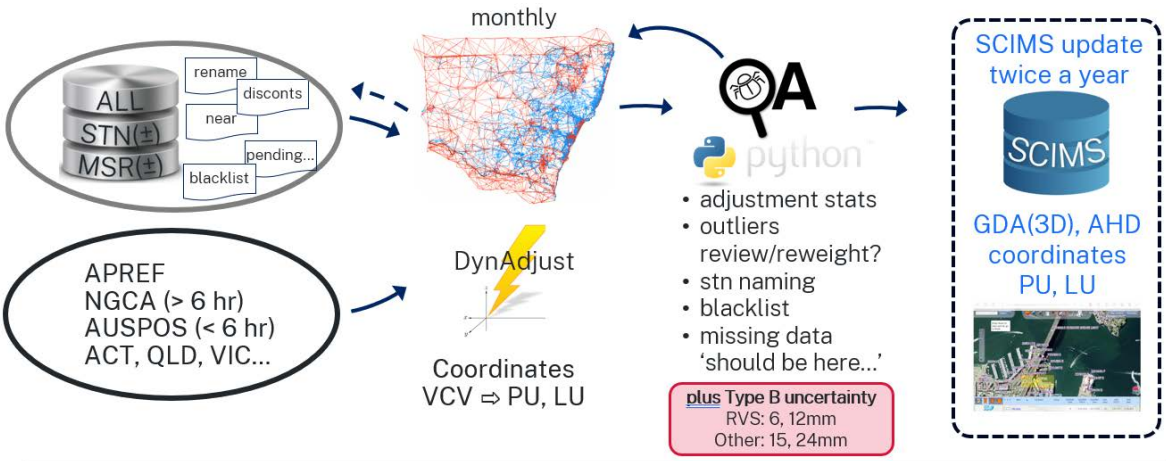
NSW state adjustment – Process

SCIMS update, twice a year (May, Nov)



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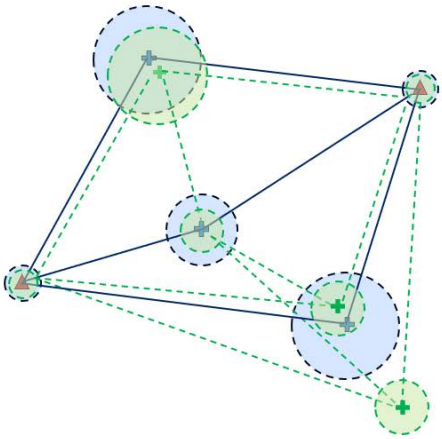
SCIMS updates coordinates twice a year

...but the marks are NOT (usually) moving



Each new measurement supports:

1) Better estimate of coordinates
   Better estimate of uncertainty

2) Comparison of techniques & campaigns
   - not every measurement is made equal
   - review (and re-weight?) measurements if needed

But if a mark adjusts to a new location:

3) Identify mislabelling?
   e.g. SS1234 ⇨ PM1234

4) Identify mark movement / discontinuity?

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SCIMS updates
NSW State Adjustment, twice a year (May, Nov)

State Adjustment (May, Nov)
(* where we have measurements; ½ of SCIMS)

- Coordinates (rigorous, adj)
- PU, LU
- 'One' SourceID (for ½ of SCIMS)
  - e.g. 301416 GDA2020 3D
  - e.g. 301417 AHD (derived from EHGT)
- Does NOT change Class!
  - Except if Class E or U
  - ⇨ Class D (PU < 0.1m)
  - ⇨ Class E (PU < 1.0m)
- Does NOT touch Accurate AHD

SURVEY MARK

Mark	Name	Alias
TS 12067	PORT KEMBLA CORS [P]	PTKL

Status	Date	Comments
RESTRICTED ACCESS	21-NOV-2011	

Location	Monument	Date Placed	Placed By
GROUND LEVEL	CONC PILLAR	16-SEP-2009	LAND & PROPERTY INFORMATION -

MGA2020/GDA2020

Horizontal coordinates are adjusted (or initialised) in GDA2020

MGA2020 Easting	MGA2020 Northing	Zone	GDA2020 Latitude	GDA2020 Longitude
308399.664	6183139.724	56	-34° 28' 31.95059"	150° 54' 49.32102"

Class	Positional Uncertainty	Local Uncertainty	GDA2020 Updated
3A	0.01	0.02	16-NOV-2023

Source	Type	Method	Date issued	Issued By
301416	ADJUSTMENT	DYNADJUST	6-NOV-2023	JOEL HAASDYK

Previous Reference	Location	File Number
n/a	n/a	n/a

Comments
GDA2020 STATE ADJUSTMENT NOV 2023

... and similar for GDA2020 EHGT, and AHD71

SCIMS updates
from all mechanisms

State Adjustment (May, Nov)
(* where we have measurements; ½ of SCIMS)

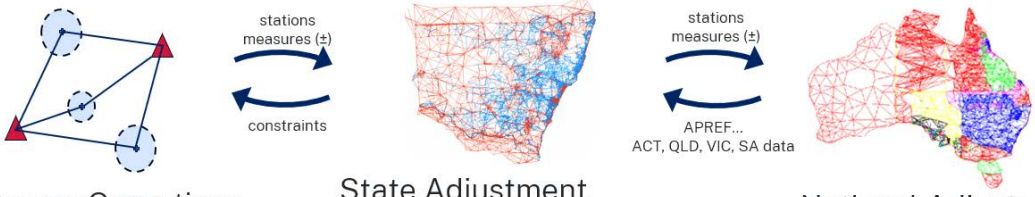
- Coordinates (rigorous, adj)
- PU, LU
- 'One' SourceID (for ½ of SCIMS)
  - e.g. 301416 GDA2020 3D
  - e.g. 301417 AHD (derived from EHGT)
- Does NOT change Class!
  - Except if Class E or U
  - ⇨ Class D (PU < 0.1m)
  - ⇨ Class E (PU < 1.0m)
- Does NOT touch Accurate AHD

Other SCIMS update methods

- SurveyOps (on demand, business as usual)
- AUSPOS (monthly; internal & external data)
- Edmark (new stations from LSPs; station updates)
- Missing heights: (twice a year: May, Nov)
  - AHD & EHGT from Surface Model (new marks)
  - AHD ⇔ EHGT
- Metadata
  - from digital logsheets
  - from photos
  - from LSP (data mine old LSP [pending])
  - from *NSW Survey Marks* app
- [and in Future: LandXML?... so much data!]

NSW State Adjustment - Process

Back to the bigger picture...



Survey Operations
- Internal and External
- AUSPOS

(r) On demand SCIMS
- ⇨ Coordinates (local)
- ⇨ PU (provisional), ~~LU~~
- ⇨ Class
- ⇨ AHD

State Adjustment
- APREF, NGCA, AUSPOS
- NSW modern and historic
- ACT, VIC, QLD, SA data

(r) Monthly (for internal review)
(r) Twice a year (May, Nov) SCIMS
- ⇨ Coordinates (rigorous)
- ⇨ PU, (RU), LU (rigorous)
- ⇨ NOT AHD, NOT CLASS

National Adjustment
- APREF
- Jurisdiction data

(r) Monthly
- ⇨ Coordinates (rigorous)
- ⇨ PU (rigorous)

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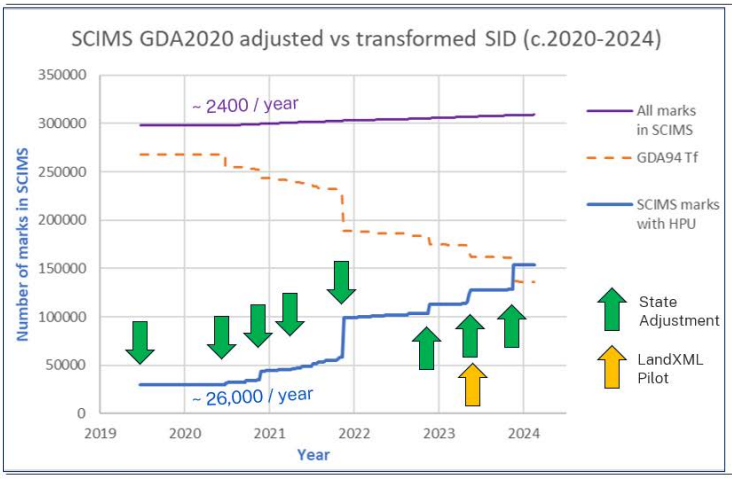
SCIMS

Adjusting to GDA2020 – Report Card



309,000 marks in SCIMS (Nov 2023)

½ (50%) now have HPU from the state adjustment

70% are **Established** in Hz
70% of these have HPU

40% are **Accurate** in AHD
65% of these have AHD-PU
(not shown in chart)

Did you know...
20% of SCIMS are witness destroyed, uncertain, restricted

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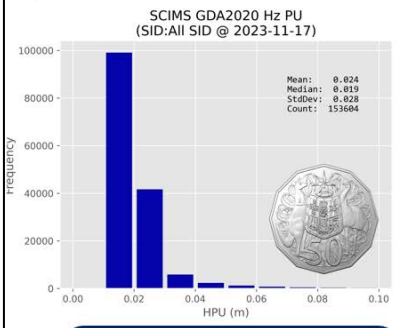
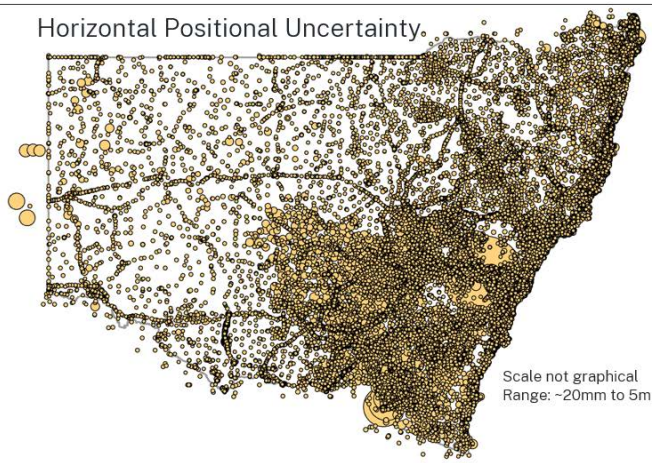
Uncertainties
SCIMS from all sources (vs NSW state adjustment values)



Horizontal	State Adj
154,000 stn with HPU	150,000
HPU < 20mm: 65%+	(similar)
HPU < 40mm: 96%+	(similar)



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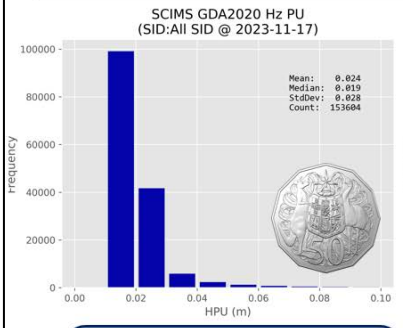
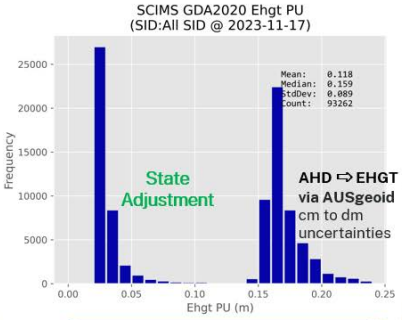
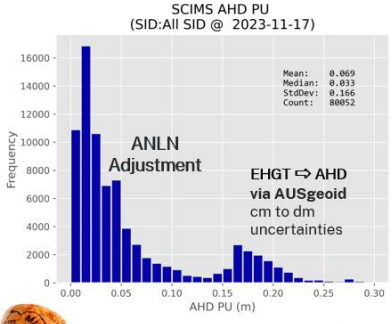
Uncertainties
SCIMS from all sources (vs NSW state adjustment values)







Horizontal	State Adj
154,000 stn with HPU	150,000
HPU < 20mm: 65%+	(similar)
HPU < 40mm: 96%+	(similar)

Ellipsoidal Height	State Adj
94,000 stn with VPU	39,000
VPU < 50mm: 40%	(95%)

AHD	State Adj
~80,000 stn with PU	10,000
AHD-PU < 50mm: 65%	(decimetre via geoid)

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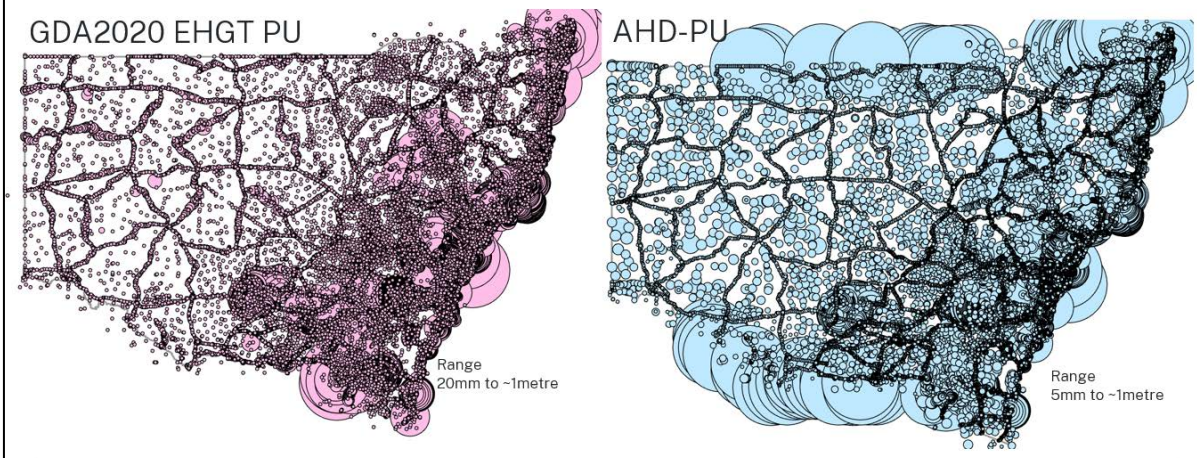
Uncertainties
SCIMS from all sources



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How can you contribute?
Every measurement and metadata helps!

"Friends ...
Romans ...
APAS..."

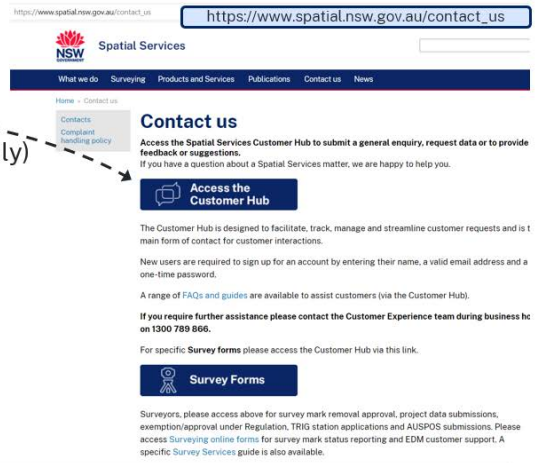
Locality Sketch Plans (LSP) (SG Dir #2)

AUSPOS
- GNSS over 2 hours via the Customer Hub)
- Very fast way to get data into SCIMS (mid-monthly)

POSI (SG Dir #11)

Submit your data (SG Dir #12)

Metadata via the *NSW Survey Marks* App
- Destroyed = *with physical evidence (!)*
- Not Found = *I looked (hard) but couldn't find it*
- Add Photos, with time & position tags (e.g. Theodolite App)



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Take home
What does this mean for you?

½ SCIMS coordinates change (improve) twice a year (May, November)

At a street-corner near you…

- Sydney metro area largely complete by Nov2023, May2024
- POSI and BAU work are expected to become more efficient
- Metadata! Report what you find: *NSW Survey Marks* App

Coordinates with "Known Uncertainty"

- PU, LU
- PU 20mm easily fits proposed Regulations ('40mm + 175ppm')
- You can measure across the road, at the given PU
- You can measure to marks by others at the given PU (e.g. Transport, SurveyorABC)

Marks without PU are transformed from GDA94…

+/- 0.2 metres
Use with caution.

All on the same datum – GDA2020 3D!

- CORS, AUSPOS, SCIMS… NSW, VIC, ACT, QLD, SA…

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